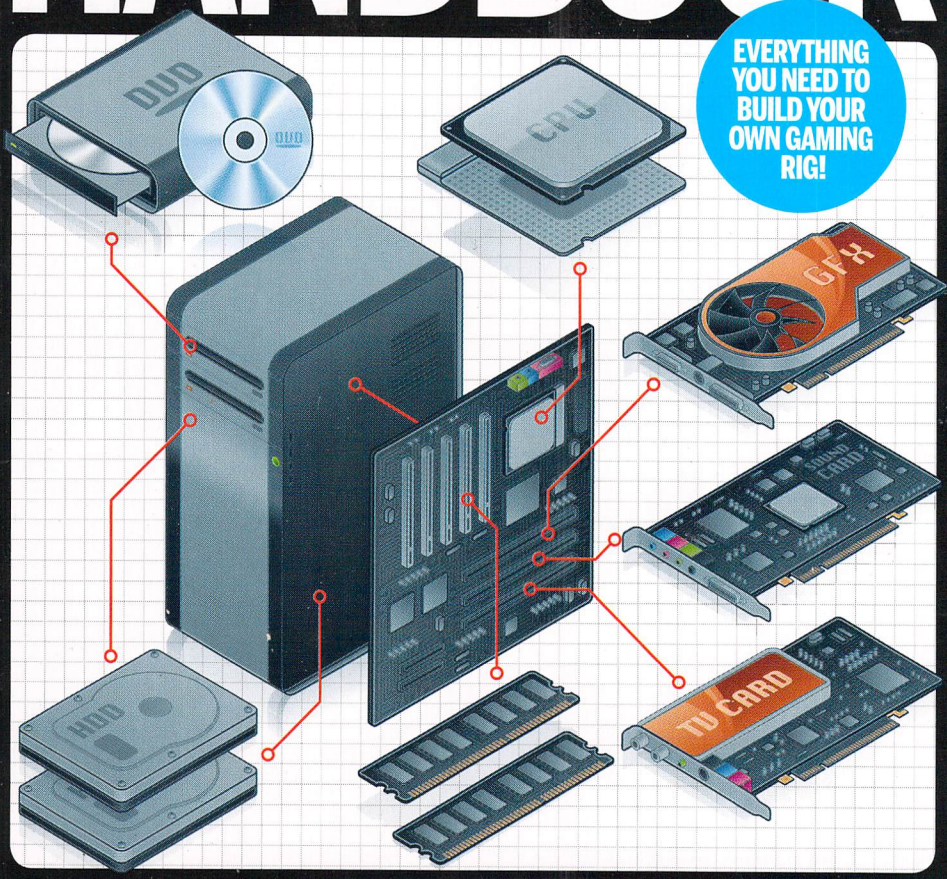
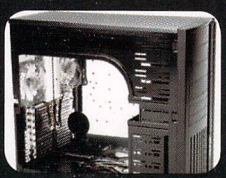
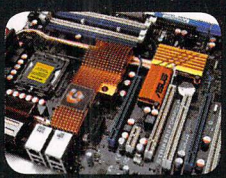
TOTAL PC GAMING PRESENTS...

THE SYSTEM BUILDER'S HANDBOOK



EVERYTHING YOU NEED TO BUILD YOUR OWN GAMING RIG!

COMPLETE WITH PICTURES, STEP-BY-STEP INSTRUCTIONS & ESSENTIAL ADVICE


THE SYSTEM BUILDER'S HANDBOOK

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IMAGINE
PUBLISHING

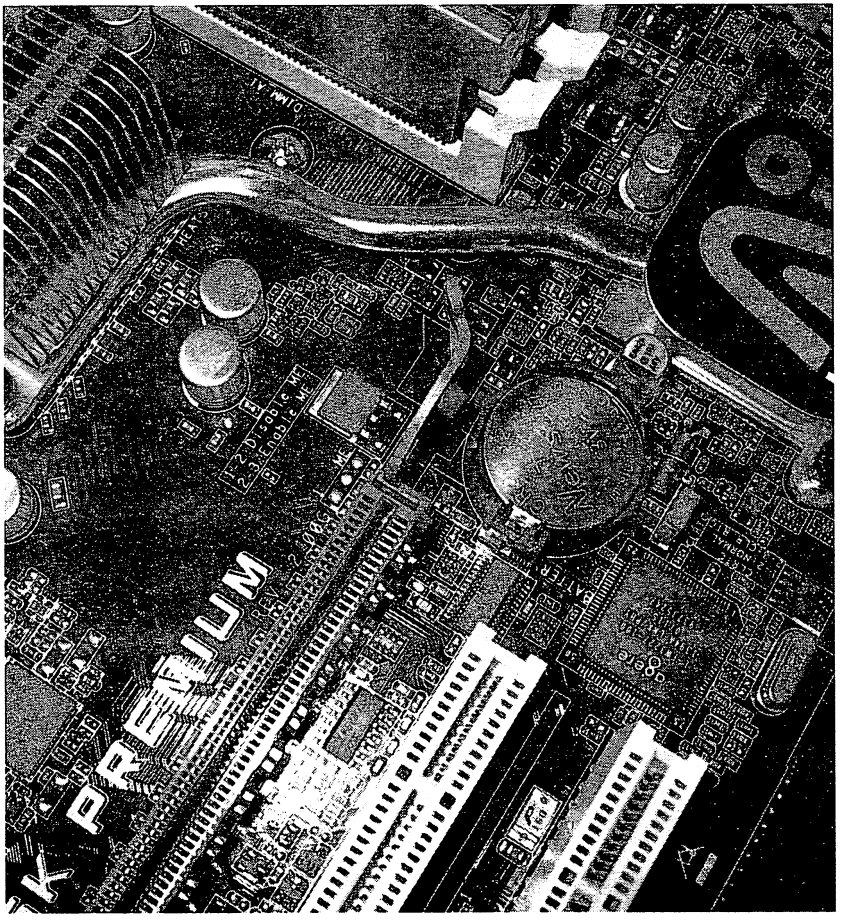
Richmond House
33 Richmond Hill
Bournemouth
Dorset BH2 6EZ

Tel: +44 (0)1202 586200
Fax: +44 (0)1202 294032
Email: tpcg@imagine-publishing.co.uk
www.imagine-publishing.co.uk

Written by:.....IAN JACKSON
Designed by.....ANDY SALTER
Sub Editors:.....DAN COLLINS AND SARAH SLEE
Printed and bound in the UK by: ... MACKAYS OF CHATHAM, BADGER ROAD, LORDSWOOD, CHATHAM, KENT, ME5 8TD

TOTAL PC GAMING PRESENTS... THE SYSTEM BUILDER'S HANDBOOK

PART 1: INTRODUCTION



Building your first PC can be a daunting prospect, but it really doesn't need to be. Most of the components essentially fit together in only one way, so your chances of permanently wrecking anything are very slim. By using our step-by-step guide you can build a system to a standard that even professionals would be proud of, correctly set up the BIOS and install your OS of choice. The end result will be a system just as good – if not better – than one you can buy off the shelf.

Building your own system instead of buying a pre-built one has a number of key advantages. One of the most important is that it enables you to select all of the relevant components without exorbitant customisation charges. While a few system suppliers are fully transparent with their specifications, all too many are vague about the parts you are actually paying for. There is a world of difference, for example, between a high-quality Asus motherboard and a generic Intel chipset model, and likewise with memory and hard drives. Different models have very different levels of performance, so by building your own you can be sure you will have a system that works to its full potential.

By building your own machine, you will also gain one of the most powerful tools any PC enthusiast can have: knowledge. Your reliance on expensive PC stores or generous friends will be greatly reduced should the worst happen, because you already know exactly how everything has been put together – the strengths and weaknesses of your own machine, and, of course, the full specification of every single component inside the system.

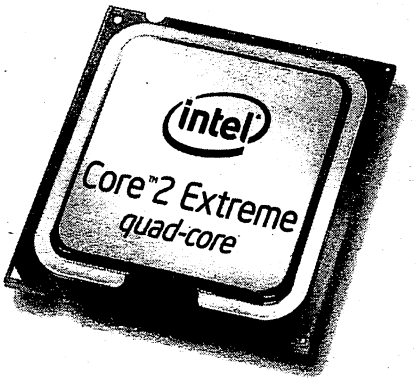
Finally, a home-built system can be added to and customised as little or as much as you like, all without jeopardising the warranty. All computer parts come with at least a year's cover, so you will still be entitled to replacement parts should something go wrong.

PART 2: CHOOSING THE RIGHT COMPONENTS

CPU

The first component you need to choose in any PC system is the processor, as it will dictate the kind of platform you go with. You can't, for example, mix and match Intel CPUs with motherboards designed for AMD processors, so it's important to get this part right. The best performing processors around at the moment are the Core 2 series from Intel. These use a 'land grid array' socket type with 775 pins. A land grid array differs from a conventional socket by virtue of the pins being mounted to the motherboard rather than the underside of the CPU.

Core 2 processors are available in a number of different flavours, with some chips offering more or less on-chip cache, different front-side bus frequencies and a variety of clock speeds. Rather than being designated by their family and clock speed as they were years ago, all Intel processors now have a model number. While the huge array of different ones available can definitely be daunting, there is a certain amount of logic to Intel's nomenclature – at least some of the time! By looking at the following table you can work out what each of the model numbers actually mean.



Core 2 Duo E4xxx	65nm dual-core processor with 2MB of cache
Core 2 Duo E6xxx	65nm dual-core processor with 4MB of cache
Core 2 Duo E7xxx	45nm dual-core processor with 3MB of cache
Core 2 Duo E8xxx	45nm dual-core processor with 6MB of cache
Core 2 Quad Q6xxx	65nm quad-core processor with 8MB of cache
Core 2 Quad Q9xxx	45nm quad-core processor with variable cache
Core 2 Extreme X6xxx	65nm dual-core processor with 4MB of cache
Core 2 Extreme QX6xxx	65nm quad-core processor with 8MB of cache
Core 2 Extreme Q9xxx	45nm quad-core processor with 12MB of cache

From the table above, you can deduce that the first letter in the product name designates the family (E for Core 2 Duo, Q for Core 2 Quad and X or QX for Core 2 Extreme). The first number designates the manufacturing process, the second number the relative clock speed, and the last two numbers normally designate other minor differences between similar chips (like the front-side bus frequency). If we take the E6700 as an example, we now know it is a Core 2 Duo with a 65nm manufacturing process. It runs at 2.66GHz, and has a 266MHz FSB. The E6750, on the other hand, is still a 65nm Core 2 Duo that runs at 2.66GHz, but has a faster FSB of 333MHz making it slightly quicker. The Q6700 is a quad-core 65nm processor that also runs at 2.66GHz.

Regardless of the model number, all Core 2 processors use the LGA 775 socket, so this is the kind of motherboard you will need to shop for if you decide to opt for an Intel processor.

AMD's competition consists of two processor families. Against Core 2 Duos, the manufacturer pits its ageing Athlon X2 line, while the manufacturer's quad-core option is called the Phenom and is also available in triple-core flavours. The Phenom is a far more contemporary processor than the Athlon, and has a host of advanced features including an integrated memory controller, a 'native' quad-core design (Intel's quad cores are essentially two dual cores bolted together) and an ultra-fast HyperTransport bus instead of an FSB. Despite this, AMD's newest progeny has had a troubled start plagued with bugs and low performance. To this day it remains an interesting, but fundamentally inferior option to Intel's all-conquering line-up.

JARGON BUSTER

THE FRONT-SIDE BUS

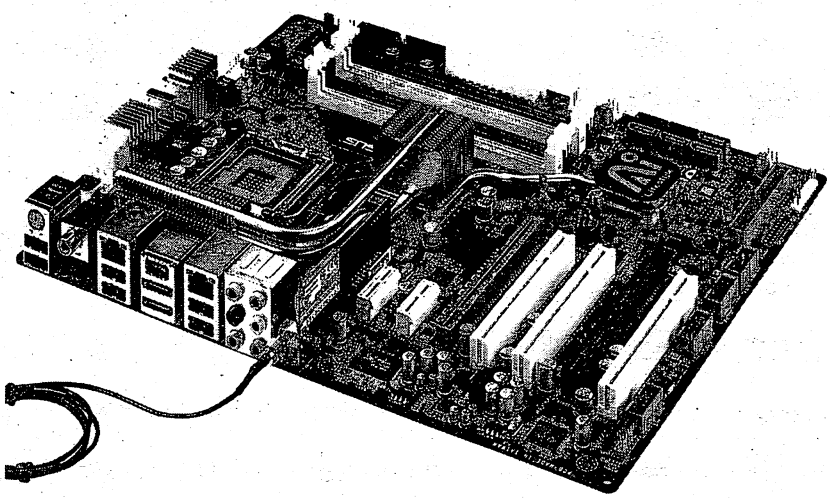
The front-side bus (FSB) frequency is the speed at which the main chipset in an Intel system operates. It controls how fast the CPU can speak to the memory and other parts of the system, and also (in conjunction with the CPU's multiplier) how fast your CPU operates.

MOTHERBOARD

Once you have chosen your CPU, the next component you need to decide on is the motherboard. This is a very important component as it forms the backbone of your PC system into which everything else interfaces. If you choose a poor-quality motherboard, you will have a poor-quality system – it's as simple as that. On each motherboard, the most important constituent is the chipset. The chipset controls what processor speeds are supported, the features available on the motherboard and the performance. There are currently two dominant chipset manufacturers for the Intel platform, Intel itself and Nvidia. Intel chipsets have a well-earned reputation for trouble-free operation and excellent performance, while Nvidia chipsets tend to be a little more problematic, but have the benefits of SLI dual video-card support and – in the case of the latest 7 series chipsets – performance equivalent to Intel's finest.

Modern motherboards now have a huge number of integrated components, many of which are so good that they have rendered the need for most add-in cards obsolete. It's now almost unfathomable to see a motherboard lacking gigabit networking or surround sound audio, and many go one step further with dual networking ports, wireless, RAID and, in some cases, integrated graphics. It's tempting to look for a motherboard with just the features you intend on using, but often this proves to be something of a red herring. This is because high-quality boards tend to be feature-rich – so you almost always have to put up with features you won't necessarily use. It is therefore more sensible to set yourself a budget range and pick the best board within those constraints.

The best value chipsets for LGA775 CPUs are the mid-ranged Intel ones, such as the P35 or P45 models. These are within a couple of per cent of the much more expensive X38 or X48 flagships, and only have a few inconsequential



differences. The only reason you might want to stretch to the expense of one of the two latter chipsets is if you plan on running two ATI cards in CrossFire, as their dual 16x PCI Express lanes can increase performance notably. Our advice is to give Nvidia chipsets a miss unless you must have SLI, as they can be troublesome and fussy with memory.

If using an AMD processor, again there are two dominant chipset manufacturers: Nvidia and AMD itself. The latter produces great CrossFire-compatible boards, while the former makes superb SLI boards that are generally much better than their Intel-based efforts.

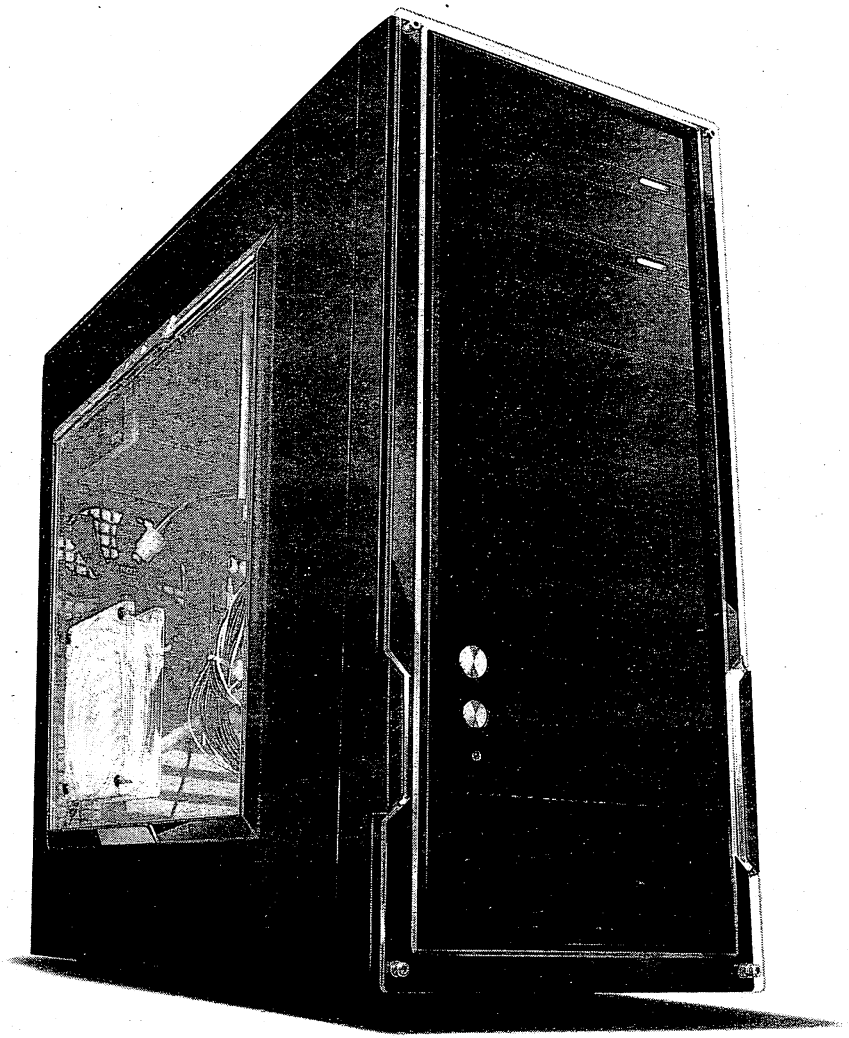
In general, the more you spend on a motherboard, the more feature-rich it will be, but it will also usually have more in the way of tweaking options in the BIOS, and will probably come with other goodies like elaborate cooling solutions and great overclocking features. If you plan to overclock, the motherboard is the single most important component to get right. If you don't, one with a good chipset and the features you need will do just fine.

CASE AND PSU

You can buy a case and PSU bundle for less than £20 from some of the larger online stores, but unless you plan on building the most basic of office boxes, you probably shouldn't. Cheap cases are generally poorly made and have only basic cooling features. The PSUs included with such a setup are also rarely capable of sustaining their claimed output for more than a few minutes, so if building something with a decent video card, you will have to fork out for a premium model.

When picking a case, you need to make sure it has the required space for your chosen components, and preferably enough for you to make some upgrades in the future as well. You also need to make sure it comes with plenty of cooling, preferably in the form of decent quality 120mm models. This doesn't mean you need to spend the Earth, though. Even premium brands like Cooler Master and Antec do cases for under £40 that offer plenty of room and excellent cooling. It is often tempting to blow out on the core components of your machine and then skimp on the case and PSU, but it's very important for both the health and lifespan of your system that you resist this temptation, especially if you are using high-end parts.

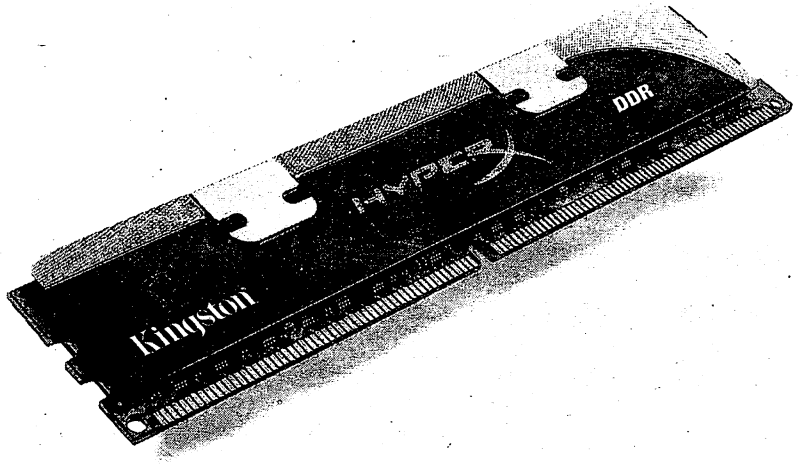
High-end power supplies are normally capable of delivering their rated output consistently, so there will be a world of difference between a premium 500W model and the '500W PSU' you can get in a £20 case. A good indicator of a PSU's quality is its weight. If it's very light you should give it a miss, as this normally means the manufacturer has skimped on important components and heat sinks, which are essential for long-term stability. The strength of your PSU will normally be governed by your video card and CPU, with more expensive models needing more power. Some of the fastest cards need truly huge amounts of energy, with the GTX 280 and HD 4870 X2 requiring at least a 750W PSU to operate correctly. Our advice would be to invest in the punchiest PSU you can afford, as this will be an important factor in the upgradability of your PC.



MEMORY

Memory is a tricky beast to understand; all current AMD systems use DDR2 RAM, while Intel systems come in either DDR2 or DDR3 flavours. Unless you have huge amounts of money at your disposal, we highly recommend you opt for DDR2 for your new Intel machine, as decent DDR3 is more than twice as expensive and requires very pricey motherboards as well. Unless you plan on overclocking, PC2-6400 (also known as DDR2-800) should be more than good enough, and is available for exceptionally low prices. It is a good idea to pay a little extra for high-quality named brands, as they are normally only a few pounds on top of the cheapest OEM sticks and come with reassuring lifetime warranties. Some of the best brands include Corsair, G.Skill, GeIL, Mushkin, Crucial and OCZ, with the differences between each manufacturer being relatively few.

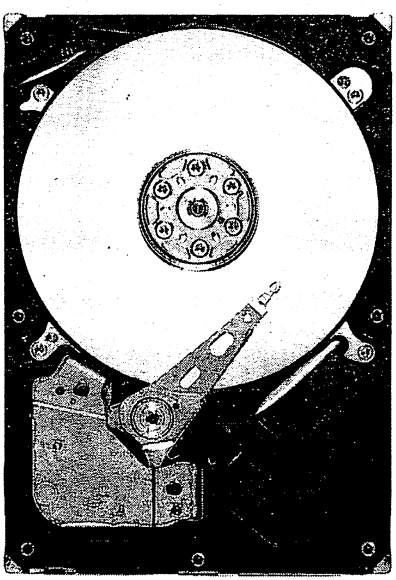
How much memory you should install is a trickier question to answer and depends on your OS. If you plan on using Windows XP, 2GB of memory will be enough for the vast majority of users. If using Vista, on the other hand, this should be considered the minimum for smooth operation. 4GB will generally give a faster ride, and, given the extremely low cost of memory, 4GB kits are probably your best option. These can be picked up for less than £50 for a matched pair if you shop around. A further complication is the amount of



memory that can be seen by various operating systems. 32-bit systems can only see up to 4GB of RAM, less that reserved by your video card and other PCI devices. This means a high-end system with a 512MB card and a couple of PCI cards might only see 3.2GB of your memory. 64-bit systems are not so afflicted, and can see essentially unlimited amounts of memory. So why aren't we all using a 64-bit OS? We will cover that a little later in our OS subsection!

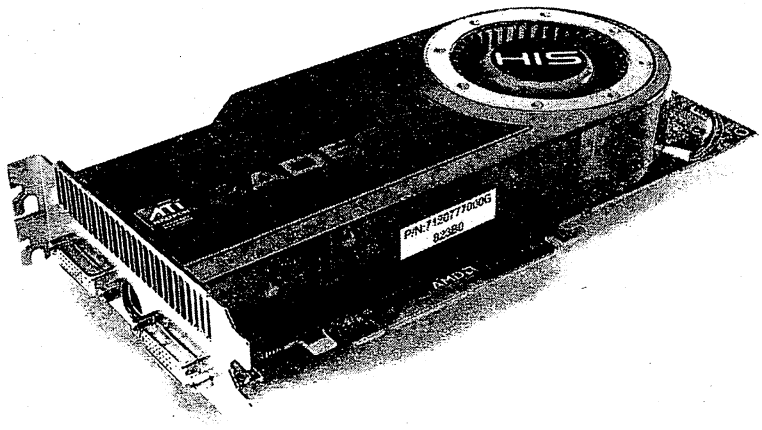
STORAGE

The hard drive is one of the slowest bottlenecks in a modern PC, so a faster model will often reap considerable rewards for the overall performance of your system. There are four specifications you need to worry about when picking a hard drive – capacity, cache, rotational speed and interface. Given the low cost of storage, most of us will be able to afford a hard drive with enough space to last us for years to come, but the other factors are still important. The cache is the amount of ultra-fast on-drive memory that stores regularly accessed files for improved performance, so a larger cache will normally mean a faster PC. Avoid drives with 2 or 8MB caches and instead opt for those with 16 or 32MB. Rotational speed will be 7200rpm for most hard drives, but if you have money to burn you may want to consider an ultra-fast Western Digital VelociRaptor drive, which will run at 10,000rpm. These drives offer up to 30 per cent more performance than a conventional disk, but are also about seven times more expensive, which makes them a tough recommendation. Regardless of what capacity drive you choose, stick to a SATA interface. There is no room in a modern system for any ageing IDE devices, and if you plan on slotting in existing IDE drives rather than investing in new ones, our advice would be to change your mind.



As well as a hard drive, you will also need a decent optical disk drive for your PC. Decent 20x or 22x DVD burners can be had for as little as £15, so our advice would be to go for one of these. All DVD burners also read and write CDs, so you will only need more than one drive if you want to make 'on-the-fly' copies.

Those with a bit more money at their disposal might want to consider a Blu-ray drive. Blu-ray has emerged as the victorious 'format of the future' over HD-DVD, so it's probably only a matter of time before games manufacturers take advantage of all that extra capacity to produce even better quality graphics and sound, just as they are already with the PlayStation 3. Blu-ray ROM drives that also burn DVDs can be picked up for around £65 if you shop around, while Blu-ray burners cost around £150 at time of writing.



VIDEO CARD

If you plan on using your system for gaming – and if you are reading this book that is probably the case – the video card is by far and away the most important component to get right. Fortunately, there has never been a better time to buy a video card, with extremely fast models available from both ATI and Nvidia at bargain prices – but if you want to play the latest games on your PC, you are going to have to spend a fair whack of your overall budget on this component, even if it means dropping the speed of your processor a little to come in under budget. The best Radeon card for frugal buyers is currently the HD 4850. This 512MB wonder-card was only released a short time ago, but totally altered the video card landscape, with Nvidia having to drop the price of all of its cards to compete. The 4850 is currently around £115 at time of going to press, and delivers extremely good performance in even the latest games – including system-busters like *Crysis*. The Nvidia alternatives at this price point consist of

the 9800 GT – essentially a rebadged 8800 GT, and the 9800 GTX – essentially a rebadged 8800 GTS with slightly higher clocks. The latter of these two provides a very decent challenge to the ATI card, and is typically available for £10-15 more. On the other hand, the 9800 GT is a good deal cheaper, and is an excellent option for those on the tightest of budgets.

If you have a little more cash to spend, consider upping to a Radeon 4870, an upgraded version of the 4850 with much faster clock speeds and GDDR5 memory. You might also want to consider one of Nvidia's GTX 200 series cards now they have considerably dropped in price, but keep in mind you will need to invest heavily in both cooling and your power supply to keep these behemoths happy. The performance offered by the 4870 is generally faster than the GTX 260, with the GTX 280 being the fastest Nvidia option of all now the awesome 9800 GX2 has been officially retired from service. The HD 4870 X2 is even faster, though at a cool £350, it will be reserved for the wealthiest PC enthusiasts.

An option many gamers find themselves considering is a dual video card setup. Dual video setups can see performance gains in the region of 30-100 per cent depending on the application. A limitation of the technology is that support for dual GPUs has to be written into both the game and the driver, so for some titles you won't actually see any benefits at all. Dual video-card solutions also tend to be more problematic, as a greater strain is placed on the chipset, which sees a huge increase in data traffic with two cards installed. This same driver and application support problem affects dual GPU cards, which feature two processors on a single PCB. Contemporary examples of these include the GeForce 9800 GX2 and the all-conquering Radeon 4870 X2.

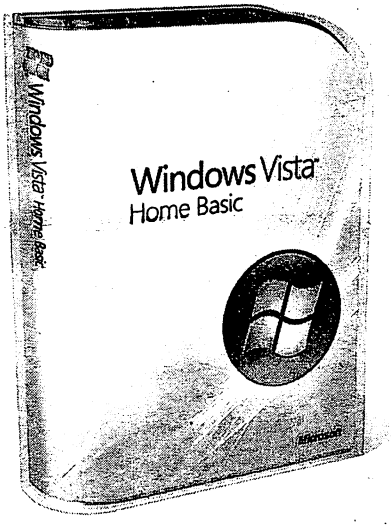
We would recommend those with a fair amount of money to spend to opt for the fastest single card they can afford rather than two mid-ranged cards in SLI or CrossFire. While the performance on paper is often similar (or slightly faster for the dual GPU options), more often than not, the niggling issues that plague multi-card setups are not worth the hassle.

OPERATING SYSTEM (OS)

Many users find the question over which OS to install more difficult to answer than what hardware to squeeze into the case. Vista has the advantage of being newer and has Direct X 10 support, while XP is generally faster and boasts fewer bugs and niggles than Microsoft's latest and (not so) greatest. In truth, many of the issues you may have seen documented about Vista have been greatly exaggerated, and most people – once they get used to it – find using Vista to be an enjoyable experience. Vista is also generally a lot faster to set up and configure, as its driver bank is more comprehensive than XP's. One annoyance present in Vista that we feel important to mention is the dreaded User Account Control (UAC). This is a security layer that prompts the user for confirmation after you select any option that has the smallest potential to affect your configuration. Clicking on the Control Panel's device manager, for example, will result in the screen going black and the system completely halting until you give Windows permission to continue. Fortunately, this highly intrusive and generally unhelpful option can be disabled in the 'User' section of the Control Panel – something we recommend all savvy Vista users who want to keep their sanity intact do as soon as they hit the desktop.

Another tricky decision you will have to make is whether you go for a 32-bit version of XP or Vista, or opt for the 64-bit variants. The latter has the advantage of greater performance where 64-bit code is available (it generally isn't), and more importantly, the ability to overcome the 4GB limit inherent to 32-bit operating systems. The problem that prevents this from being the obvious choice it initially appears to be is one of compatibility. When it comes to running older applications and games, 64-bit versions of both XP and Vista are notoriously fussy. While some can be made to work using 32-bit emulation or compatibility modes, many stubbornly refuse to work. This won't be an issue if you have all-new hardware and only play the latest titles, but if you still want the option to load up a few old faithfuls, carefully check compatibility before opting for a 64-bit OS.

One final option you can opt for is to dual-boot both Vista and XP. If doing this, we recommend using a 32-bit version of XP with a 64-bit Vista install. That way, if you need to use older programs you have the older OS to fall back on, while your new OS investment won't be obsolete in the next few years when 4GB of memory is seen as pitifully inadequate.


Windows Vista
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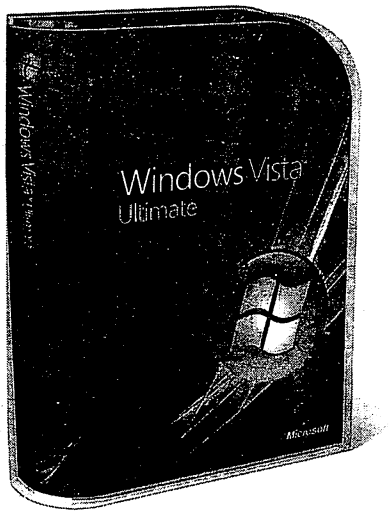
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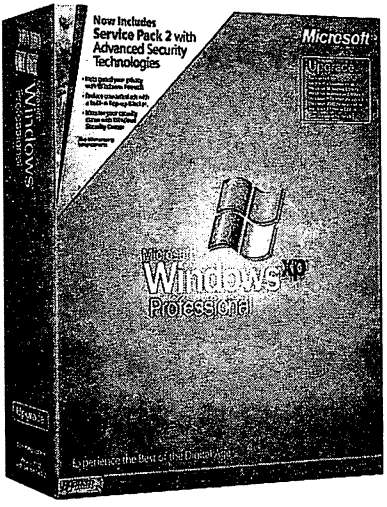
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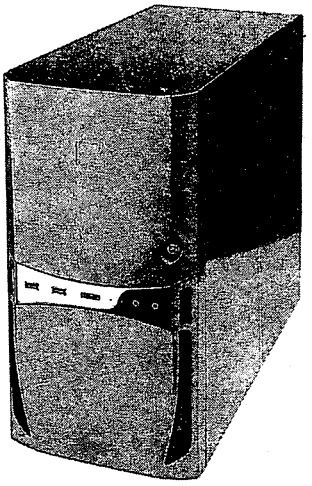
PART 3: DIFFERENT USAGE SCENARIOS

The same specification won't cater for everyone's needs, and having essentially unlimited flexibility with your components is one of the great strengths of building your own PC. Here are a few typical configurations you might want to consider. All prices correct at time of writing.

THE OFFICE BOX



It's common knowledge that you don't need a serious amount of horsepower to use Microsoft Office and browse the internet, but by the same token, if you skimp too much on the specification, your new machine could be obsolete before you know it. Office machines can normally get away with a fairly basic motherboard as you are unlikely to want to overclock such a machine. You also won't need the latest quad-core processor, as most Office tasks run just fine on just a single core, let alone four. 2GB of RAM should be more than enough memory for all but the most inefficient multi-taskers, and unless you are working with huge video files, storage will not be of paramount importance. A decent specification for a typical home-built office workstation would be as follows:

TYPICAL SPECIFICATION

Core 2 Duo E7200 CPU
2GB PC2-6400 RAM
Asrock 945 1333-GLAN motherboard
GeForce 7200GS video card
Antec Case and 380W PSU
20x SATA DVD-RW drive
250GB SATA hard disk
Windows Vista Home Premium 64-bit

APPROXIMATE SYSTEM COST: £300

The above specification is perfect for office tasks. Colossal cases and PSUs are certainly not necessary, so we have opted for a quiet and well-built Antec bundle instead. While boards that support on-board graphics exist, they can be sluggish when dealing with Vista, and a standalone card will enable you to add a second screen later, which can be very useful if you find yourself comparing more than one data set at a time or spend a lot of time researching online.

THE BUDGET GAMER

A budget gaming PC is probably what most first-time builders have their eyes on, and the good news is that a surprising amount of power is available for less money than you might think. Gamers that plan on playing at decent levels of detail will want to invest in more memory, a faster motherboard, a much better video card, a cooler and a quieter case. For gaming at any budget, at least an 8800 series GeForce or 3800 series Radeon should be considered mandatory. While cheaper cards are available, they simply are not up to the task of running intensive modern games like *Crysis* and forthcoming blockbusters like *Grand Theft Auto IV* and *Far Cry 2*.

TYPICAL SPECIFICATION

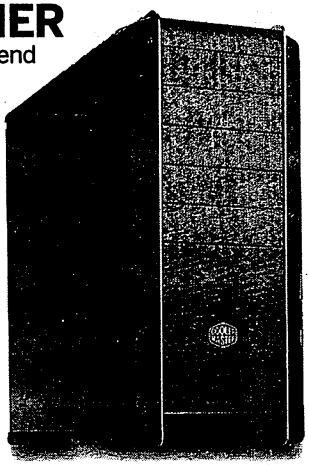
Core 2 Duo E7200 overclocked to 3GHz+
Asus P5Q motherboard
4GB PC2-6400 DDR2 memory
Nvidia GeForce 9800 GT 512MB video card
Cooler Master Elite 330 case
Decent 500w branded power supply
20x SATA DVD-RW
250GB SATA hard disk
Windows Vista Home Premium 32-bit

APPROXIMATE SYSTEM COST: £450

We have saved money on the chip to allow us extra punch in the video card and motherboard. Investing in the latter gives us considerable overclocking headroom on the E7200 processor, and novices should easily be able to hit the 3GHz range just by upping the front-side bus to 333MHz.

THE MAINSTREAM GAMER

A mainstream gamer will normally be willing to spend a bit more cash in order to get a system that is more future-proof than our budget offering. The budget offering, though nippy, doesn't have the quickest of video cards, and also has no real room for future expansion due to its limited case and PSU.



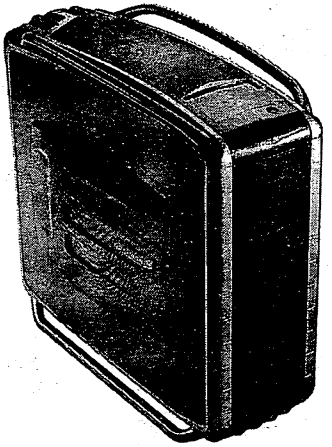
TYPICAL SPECIFICATION

Core 2 Duo E8500 processor (overclock optional)
Asus P5Q Pro motherboard
4GB PC2-6400 DDR2 memory
AMD Radeon 4870 512MB video card
Cooler Master CM-690 case
Decent 650W branded power supply
20x SATA DVD-RW
500GB SATA hard disk
Windows Vista Home Premium 32-bit

APPROXIMATE SYSTEM COST: £700

Our mainstream spec is superior in a number of areas. Firstly, the processor has more cache and runs at a faster FSB and clock speed. Overclocking is still possible, and higher clock speeds would be more obtainable than with our budget spec. 4GB of PC2-6400 is still the best bet at this sort of price point, though we have increased the motherboard to a P5Q pro, which features more in the way of tweaking options and is also CrossFire ready for later expansion. The 650W PSU will also be capable of supporting forthcoming faster video cards when they arrive on the scene. A larger hard disk will allow more games to be installed at the same time, providing a greater choice for those that play online.

THE EXTREME GAMER



Our extreme gamer spec is designed to cater for those who play a lot of games and therefore want to enjoy them at the highest possible settings. It is not a 'money no object' PC, as we simply don't think a significant number of people are willing to shell out thousands and thousands of pounds on a PC that will be yesterday's news in as little as six months.

TYPICAL SPECIFICATION

Core 2 Quad Q9450 overclocked to 3GHz+
Asus P5Q Deluxe motherboard
4GB Corsair PC2-8500 memory
AMD Radeon 4870 X2 2GB video card
Antec Twelve Hundred gaming case
850W Thermaltake Toughpower PSU
Blu-ray ROM drive
20 x SATA DVD-RW
750GB SATA hard drive
Creative X-Fi Xtreme Gamer sound card
Windows Vista Home Premium 32-bit

APPROXIMATE SYSTEM COST: £1250

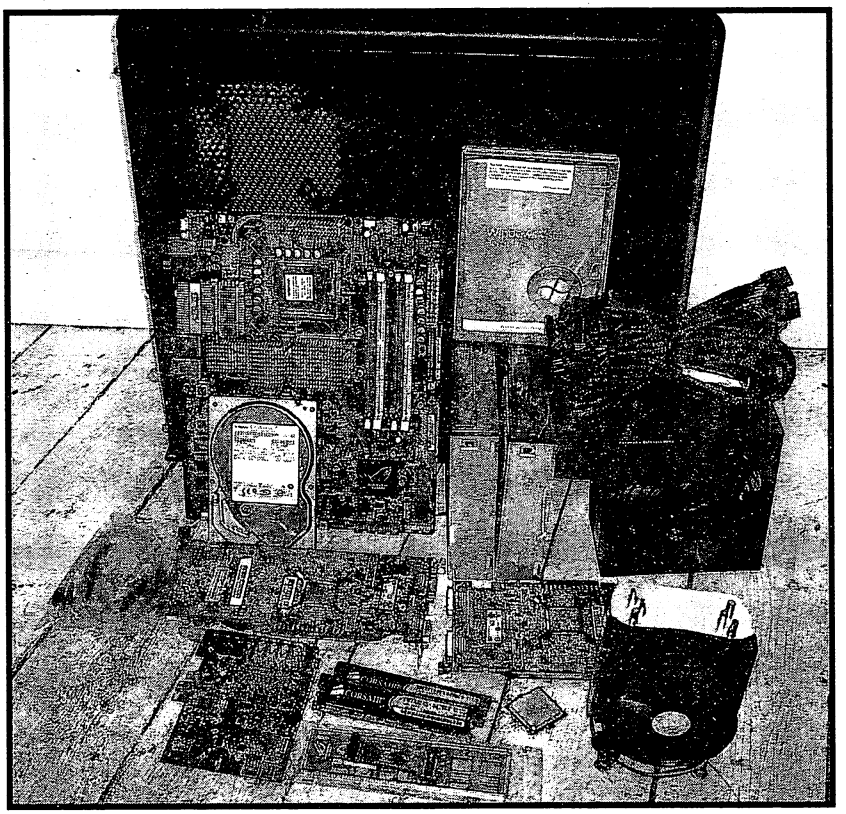
We think the above spec, despite its opulence, still delivers excellent value for money considering all that performance. Remember, to get the best out of a machine with such a high spec, you will need peripherals to go with it. There is little point investing in a video card faster than a single Radeon 4850 or GeForce 9800 GTX unless you have at least a 24-inch screen that supports high resolutions, otherwise all that extra power will go to waste, pushing pixels at speeds you will never be able to differentiate over much more modest systems. Extra storage and a premium sound card will add flexibility to the system, while the Blu-ray drive will allow for future proofing and HD movie support right now.

PART 4: STEP-BY-STEP BUILDING GUIDE

Without further ado, it's time to start the build process. To cover all the steps you are likely to need, we are building a high-spec dual video card system featuring a Core 2 Quad CPU, dual Radeon 4850s and other high-spec components.

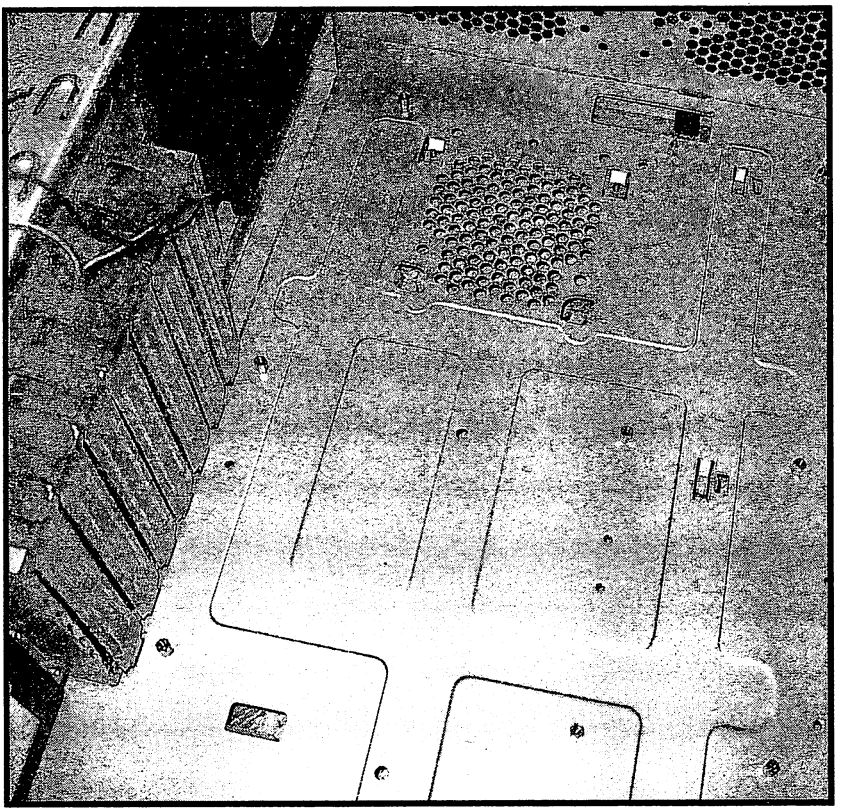
1. UNPACK ALL OF YOUR COMPONENTS

When building a PC it is important that you work in a tidy, organised manner. You simply can't afford to have piles of packaging and screws all over the floor, otherwise components can be damaged and you can easily lose track of where you are in the build. We recommend you remove all of your components from their packaging and take the empty boxes into a different room. Keep all of your disks, cables and accessories in a single box as you might need them later. Don't throw away your boxes yet, you might need them if any part is defective!



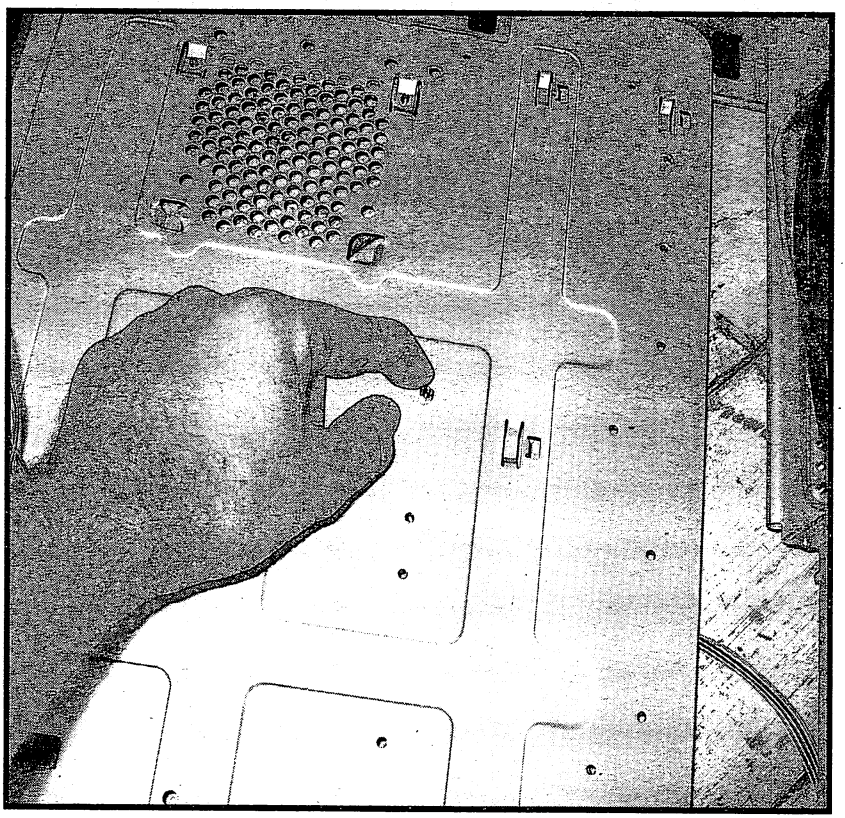
2. CHECK COMPONENTS FOR DEFECTS

With all of your parts unpacked, it is time to check all of them for physical damage and defects. This is especially important for OEM components as these usually come with minimal protective packaging. Common problems to look for are bent processor/socket pins, PCB scratches, loose surface components like capacitors and impact damage to optical and hard drives. You would be unfortunate to experience a damaged component, but if you don't check, you could install a part that might cause damage to the rest of the PC if used. If you find any damage, box the offending part back up and contact your supplier for a replacement.



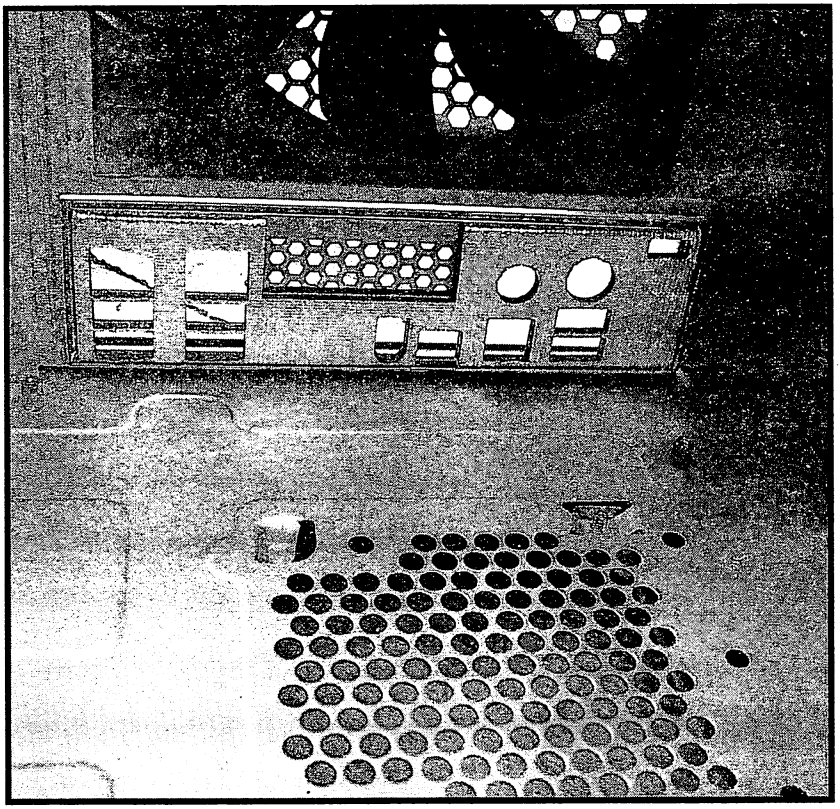
3. REMOVE SIDE PANELS

With your case unpacked, you now need to remove the side panels to gain access to the PC's interior. Our case is a Cooler Master CM-690 – a high-quality but relatively low-cost chassis with a mixture of tool-less and traditional mountings for the hardware. This case's side panels can be removed without the need for tools as it has two thumbscrews on either side, but many cheaper cases will require a Phillips screwdriver to take off the coarse-threaded screws. Once you have the side panels removed, take out the case's accessories box and separate like screws into piles.



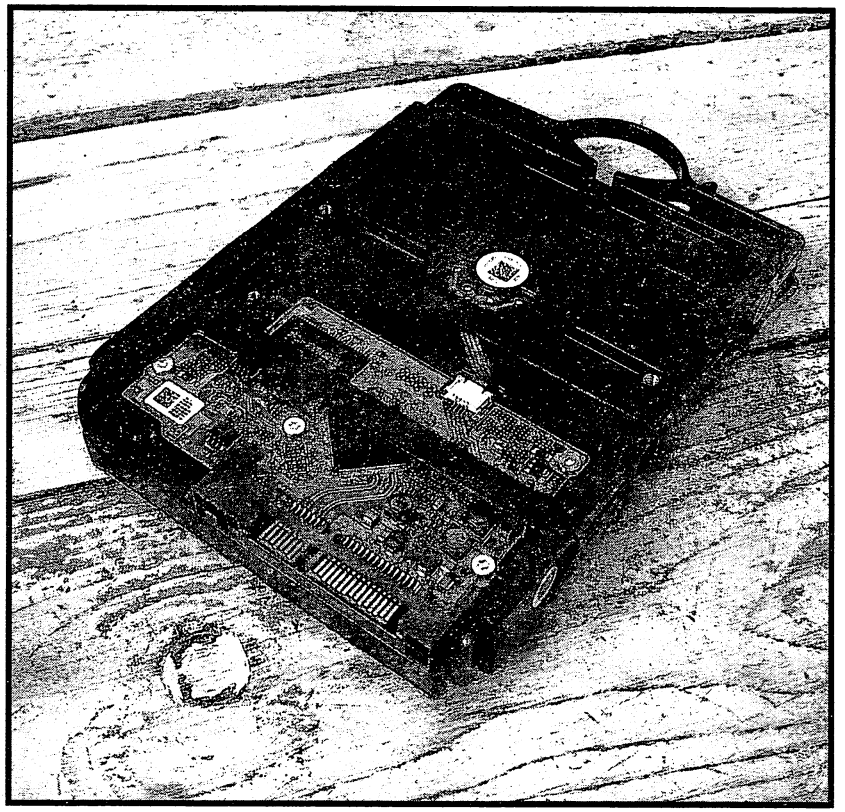
4. SCREW IN STANDOFFS

Motherboards attach to computer cases via little hexagonal hollow screws called standoffs. Some cases use coarse threads, and others fine, so you should always use the standoffs that came with the case you are using. Most ATX boards take either six or nine screws, though some take ten with an extra standoff between the video card and PCI slots. You should *never* install unneeded stand offs, as these can cause shorting between the case and important motherboard surface components, which can cause permanent damage. Line up the mounting holes in the board with those pre-drilled in the case to determine correct standoff placement.



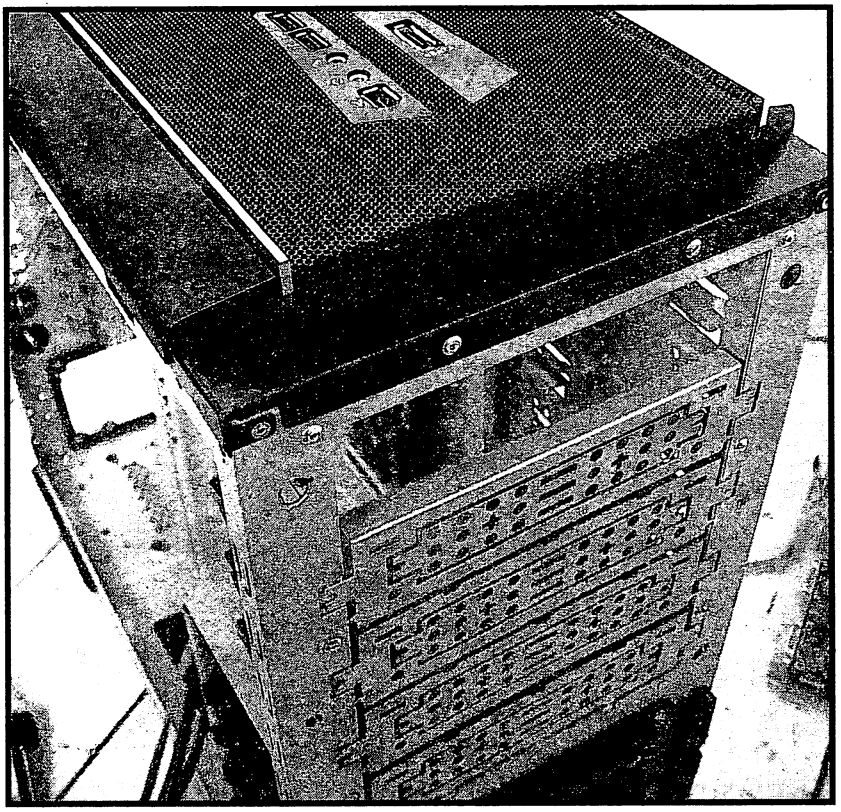
5. INSTALL I/O SHIELD

If your case has one, bash out the existing I/O (input/output) shield with the handle of a screwdriver and pop in the one that came with your motherboard. All motherboards have a different I/O arrangement, so you must use the right shield for the job. The I/O shield is there to help prevent static damage to the rear of the board, and it also stops dust and other debris from entering your system through the back. Most I/O shields have small, protruding metal flaps that are designed to sit on top of the motherboard components. Again, these just help with the board's grounding.



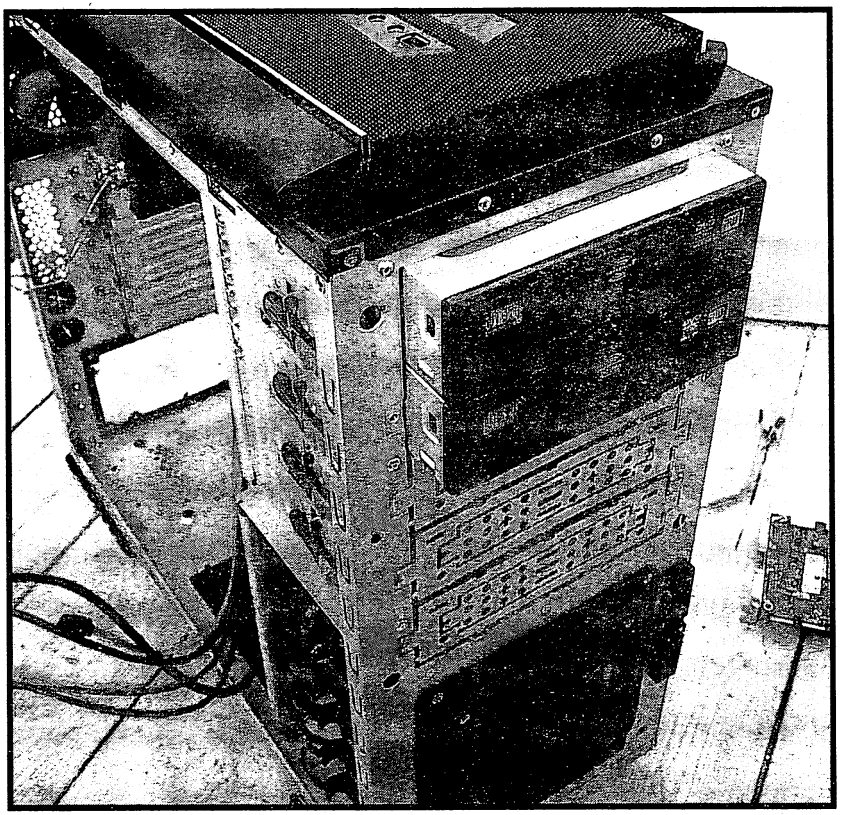
6. INSTALL HARD DRIVE

We recommend you install your hard disk at this stage, but with some cases it might be better to install the motherboard first. With the CM-690 the choice is academic, as the drive cages are in a separate little compartment to the main motherboard. In our case, the drive sits in a plastic quick-release caddy, which is useful for sliding out drives if you need to swap them out or take them with you for security purposes. Other cases require you to screw the drives directly to the chassis. Always use coarse-threaded PC screws to install hard drives.



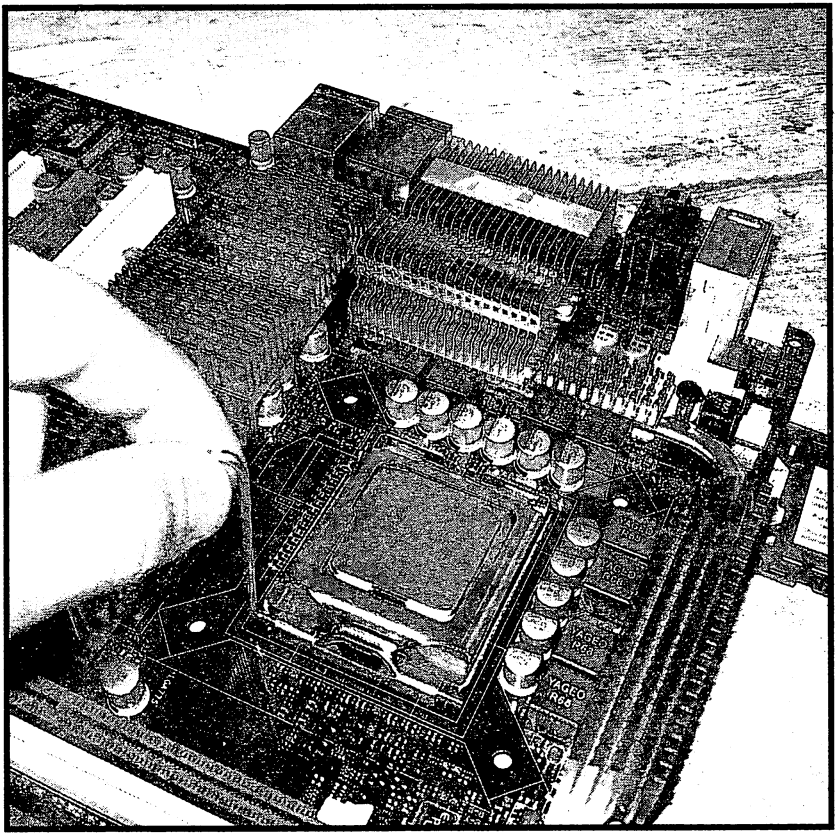
7. BASH OUT OPTICAL SPACERS

Before you can install your optical drive, many cases require you to remove a front bezel. Some cases also have a metal shield underneath the bezel that also needs to be removed, usually by inducing metal fatigue by bending them back and forth. With our CM-690, the whole facia of the case needs to be taken off in order to press out the bezels and remove the metal shields. Most expensive aluminium cases either allow you to unscrew the bezels directly or simply press them out. Only remove the shields you need to, as they help to reduce noise and reduce external EM interference.



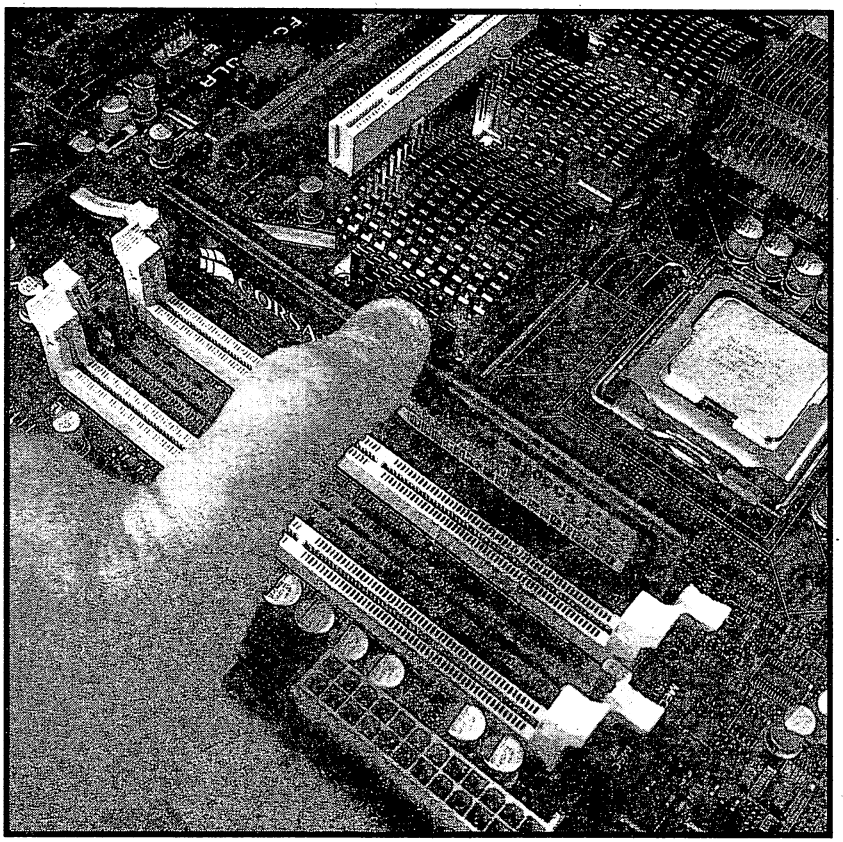
8. INSTALL OPTICAL AND FLOPPY DRIVES

With the shields and bezels removed, you can now install the optical drives. In the CM-690 there is a tool-less catch that secures the drive in place, but in most chassis you will need to use fine-threaded screws to attach the drives to the chassis directly. A floppy disk drive uses these fine screws as well, though you will need a 3.5" bay rather than the larger 5.25" type. All floppy drives use a flat IDE-style cable and a mini-Molex plug for power. Orient the coloured edge of the floppy cable towards the barrel-shaped motor at the back of the drive. The motherboard will have a blank pin that corresponds to a blocked hole on the cable.



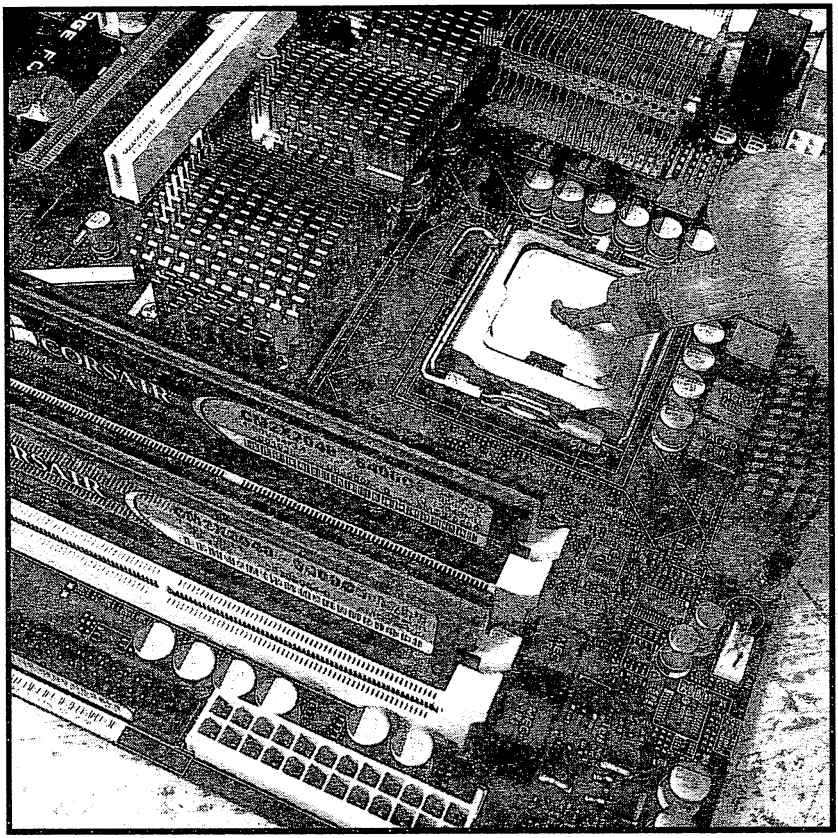
9. INSTALL CPU

In a socket 775 system, installing the CPU is a simple task, but you need to be careful not to touch any of the motherboard pins. Only remove the protective socket cover from your new motherboard when you are ready to install the processor. With the socket exposed, unhook the lever and lift the metal retention shield into its upright position. Within the socket you will notice a small protrusion on two of the edges. This corresponds to two notches on the chip and ensures it can only be installed in one way. Place the chip in position and close the shield, then use the lever to secure everything.



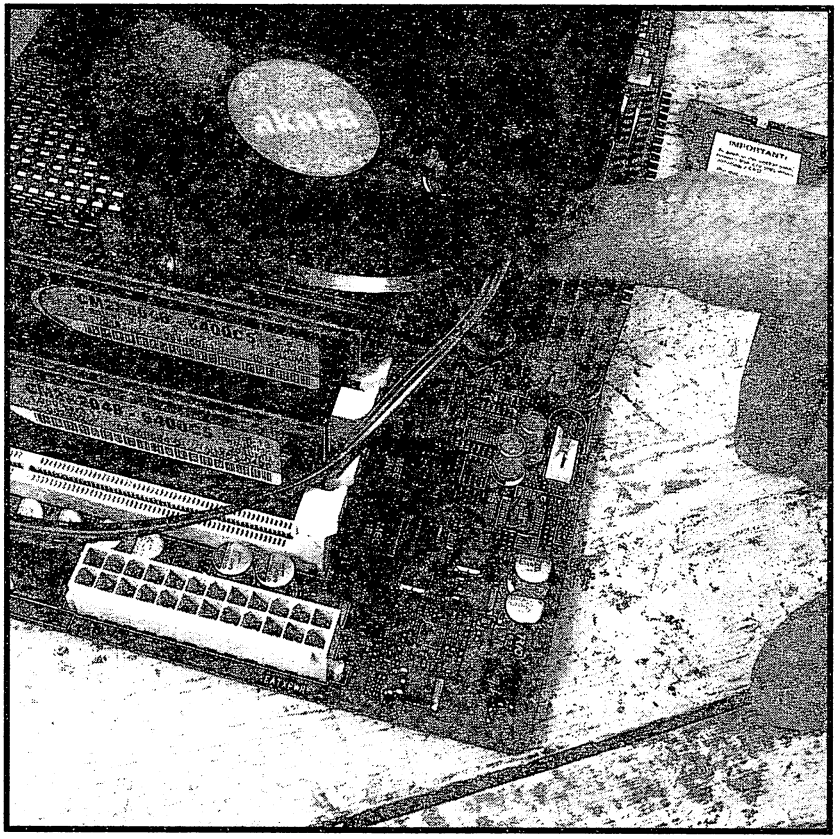
10. INSTALL MEMORY

Installing memory is another easy task, and as with the CPU, easier to accomplish before you fit the motherboard into the case. Each memory slot will have two catches at either end. Press the catches into their open position by pushing them down and away from the centre of the slot. Each slot will have a small protrusion that prevents you from installing the module upside down. Push each stick firmly into the socket until the catches automatically snap shut. Most slots are colour-coded so that you can populate them in the right order – refer to the motherboard manual for confirmation.



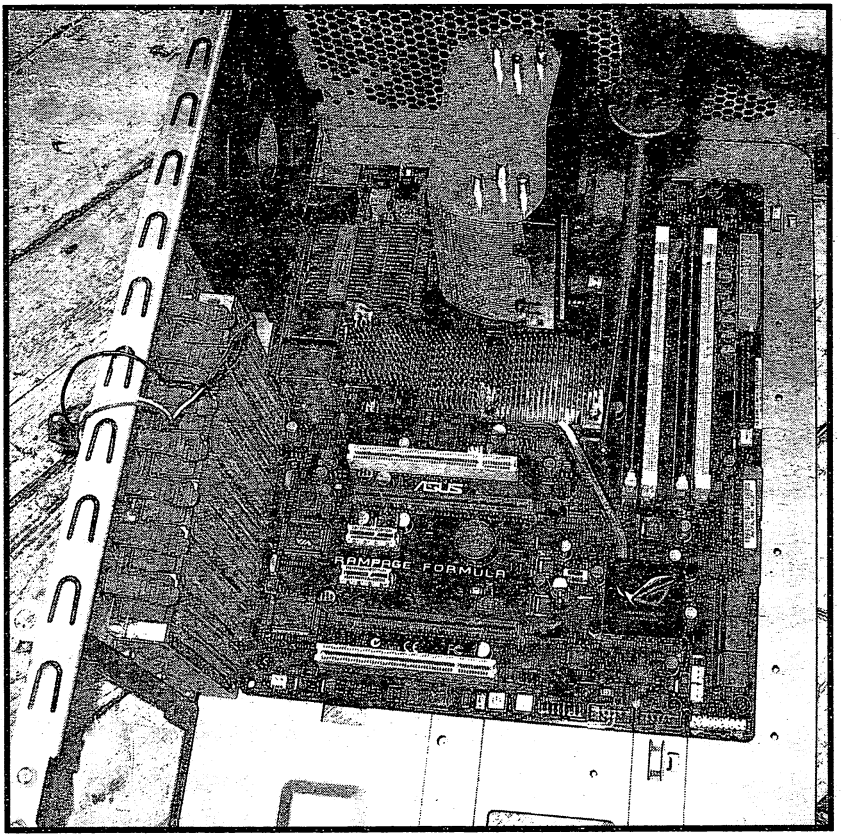
11. APPLY THERMAL PASTE

There are many different ways to apply thermal paste, and the advice you receive may conflict depending on who you ask. It is generally accepted for a processor with a heat spreader, like a Socket 775 or AM2 chip, that it is better to allow the pressure of the cooler to disperse the paste rather than spreading it flat manually for complete coverage. Squeeze an amount about 1.5x the size of a grain of basmati rice in the centre of the chip. The smoother the base of your cooler and processor, the less paste you need.



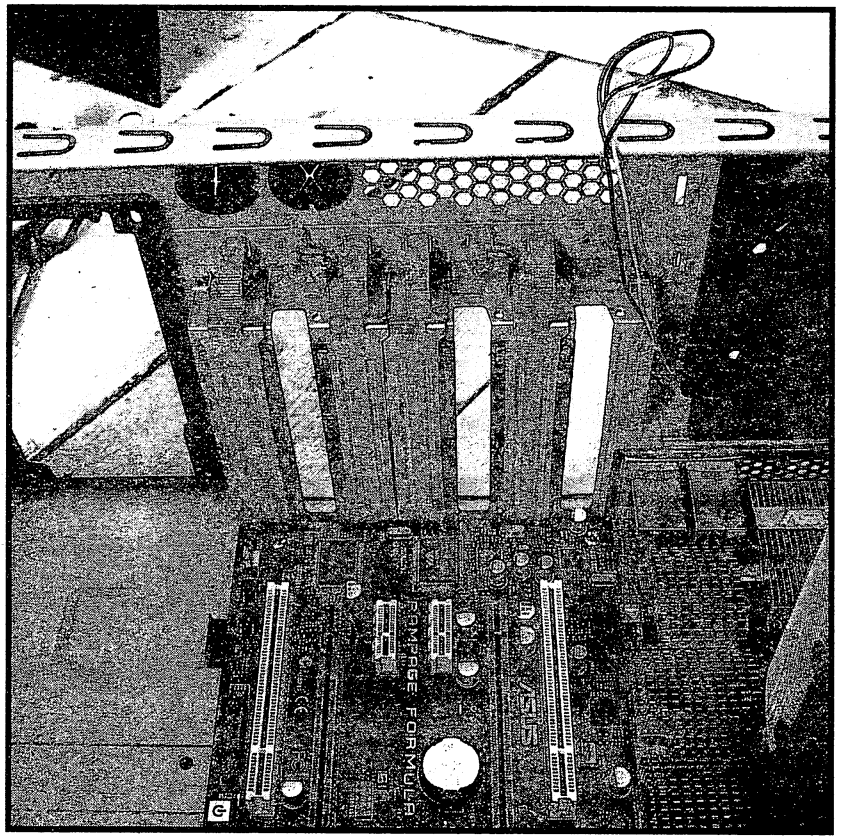
12. INSTALL COOLER

This step will differ greatly depending on what kind of cooler you fit. In this case, we are using the Akasa AK-965, a lightweight tower cooler with roughly double the effectiveness of the stock heat sink. It uses the same push-pin mounting method however, so installation is identical. Firstly, make sure all of the white parts of the four clips are in the correct, clockwise upright position. Next, insert each of the four sets of white teeth into the motherboard holes around the socket. Finally, push each of the black sections down firmly until you hear a click.



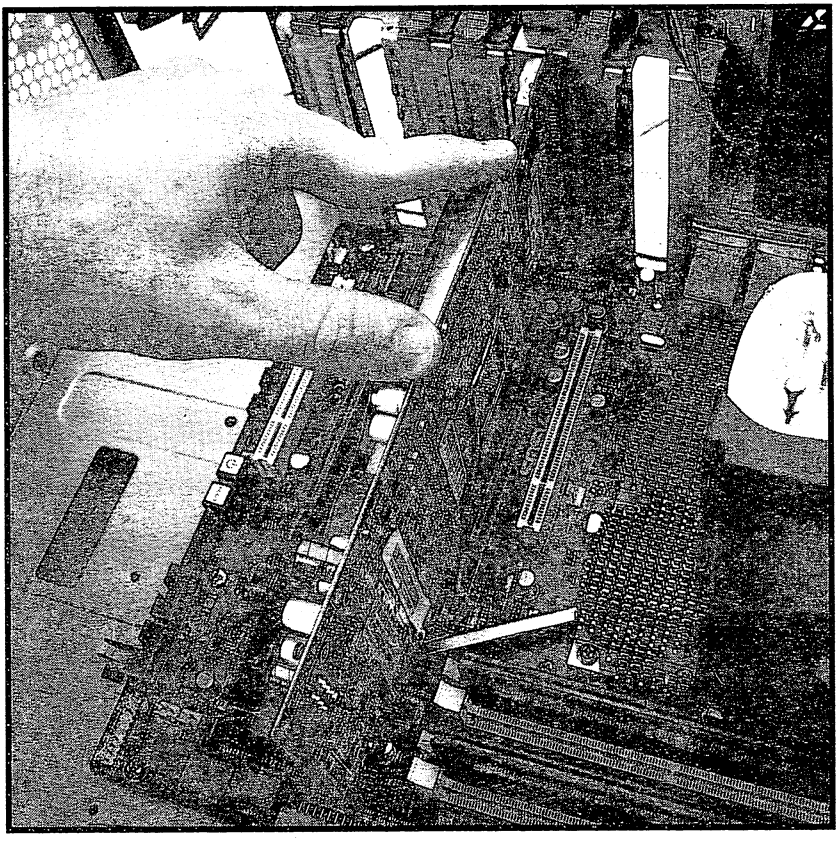
13. SCREW IN MOTHERBOARD

With the CPU, memory and cooler in place we can now fit our board into the case. To do this, carefully pick the board up by its edges and position it so that the I/O panel slots in under the protruding section of the I/O shield. Next, manoeuvre the board carefully into position so that the holes in the board line up with the standoffs. It is best to screw in the central screw first, but do not fully tighten it. This will allow you to easily move the board fractionally to accommodate the other screws. Once all mounting screws are in, you can fully tighten each of them.



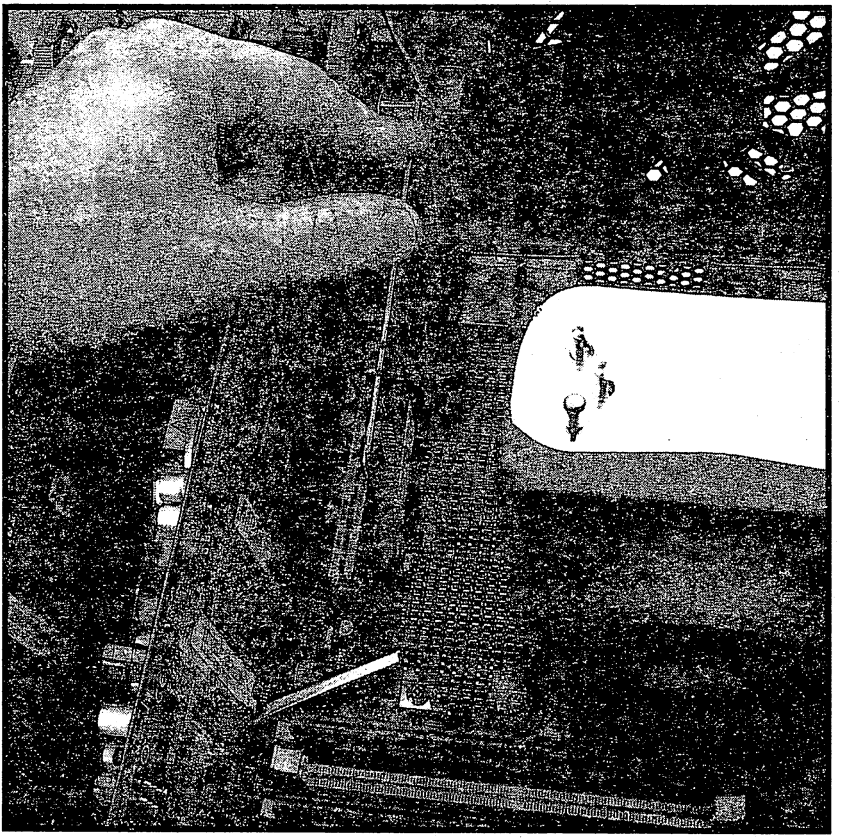
14. REMOVE PCI BACKING PLATES

With the board secured, you now need to work out what slots you want to install your add-in devices in. If you have a choice, you should position each card to allow the maximum space between each one. This will improve airflow to each card, which is particularly important if using a high-end video card. With the slots chosen, remove each corresponding backing plate (to the left and slightly below the slot). Some devices require two backing plates to be removed. Some cases use plastic clips to secure backing plates, others use coarse-threaded hard disk-style screws.



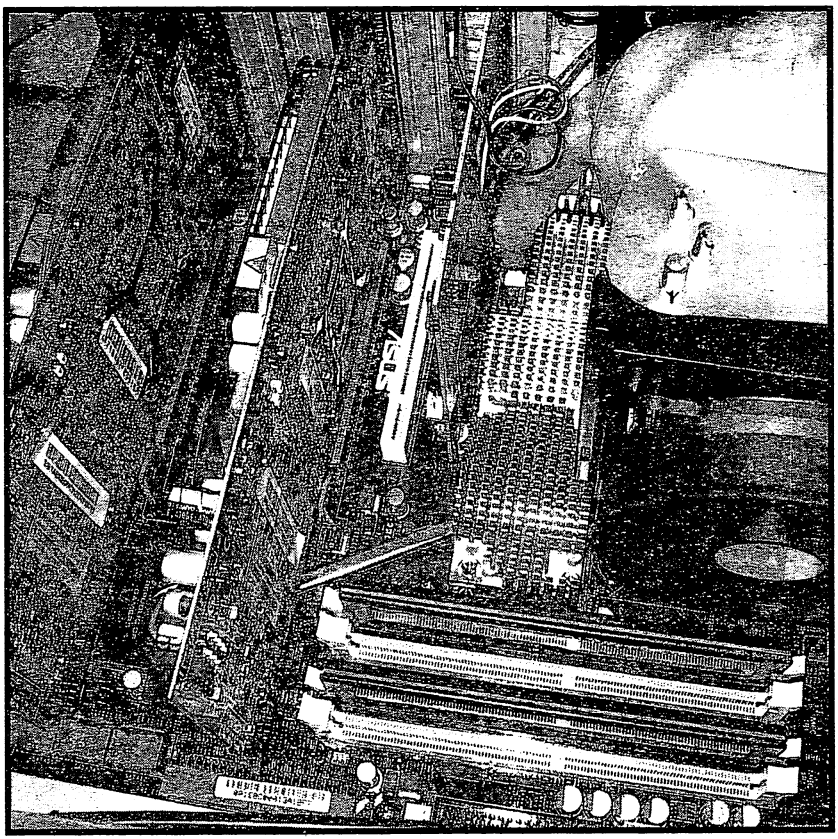
15. FIT GRAPHICS CARDS

For most systems, you will only need to install a single video card, but in our test machine we have used a CrossFire configuration of two ATI Radeon HD 4850 Cards. All modern video cards use full-length PCI express slots. To install a video card, position the contacts so that they are lined up with the slot and the backing plate, and can enter the hole in the motherboard tray. It is not uncommon to have to slightly bend the video card's backing plate in order to make it fit. Once you are lined up, push the card in carefully but firmly until no gold contacts are visible.



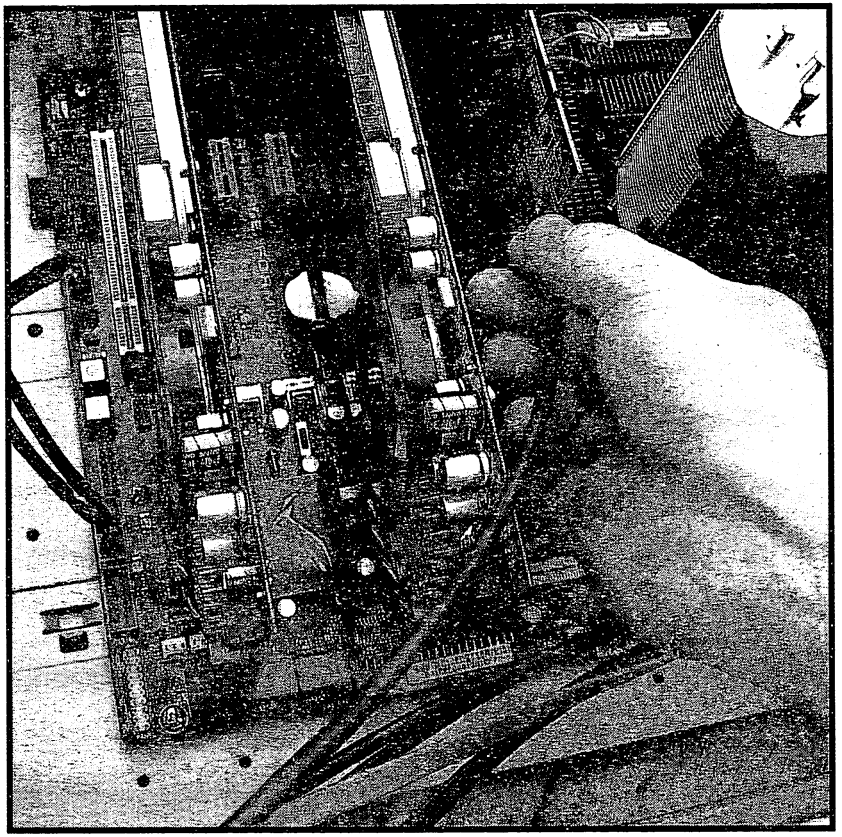
16. FIT ADD-IN CARDS

Be they PCI Express or PCI devices, installing an add-in card is just the same as fitting a video card. Most add-in cards still use the PCI interface, but some, such as the latest Creative sound cards and some TV cards, now use the much faster PCI Express 1x interface. If you have the choice, PCI Express is faster and sports a lower CPU overhead. As with the video card, you will know the card is fully inserted when all gold contacts are hidden by the slot. A slightly worrying 'crunching' sound when installing cards is perfectly normal – it's the sound of the contact pins.



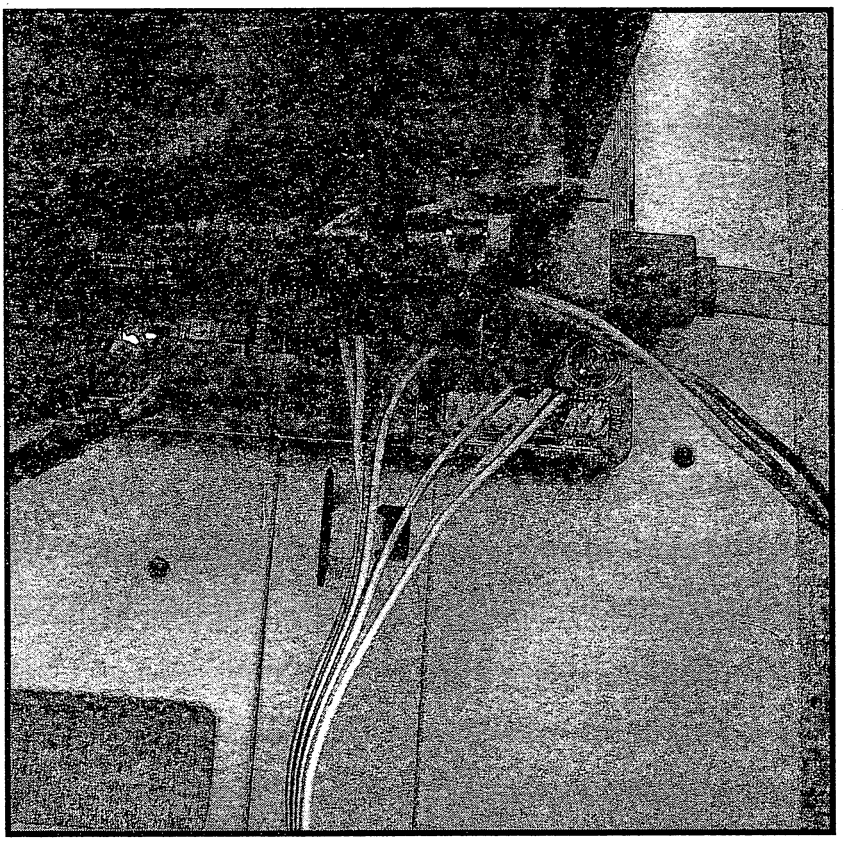
17. INSTALL CASE FANS

If you have chosen a good case, there should be at least two 120mm case fans to plug in. Most motherboards have several 3-pin fan headers. Fan headers have a plastic notch that allows you to install the fan in only one orientation. If you do not have enough fan headers for all your fans, or if they do not quite reach the header, you can purchase 3-4 pin fan adaptors, which convert a conventional PSU 'Molex' plug into a fan header. Where possible, make use of your fan headers, as most motherboards can control the fan RPM. If you haven't already, install the CPU fan's header in the same way.



18. INSTALL USB/FIREWIRE/AUDIO HEADERS

Most cases let you take USB, FireWire and audio connectivity to the front of the case to allow easier access. These case ports need to be connected to the correct pins on the motherboard. Most decent cases have their headers in a single block, though some really cheap ones need each individual wire to be attached to the board by its own single-pin plastic plug. FireWire and USB headers look the same, but are not compatible. Never install a FireWire plug on USB pins! If using an add-in sound card, see if it has a HD-audio header, if using onboard, you will need to find the header on your motherboard.

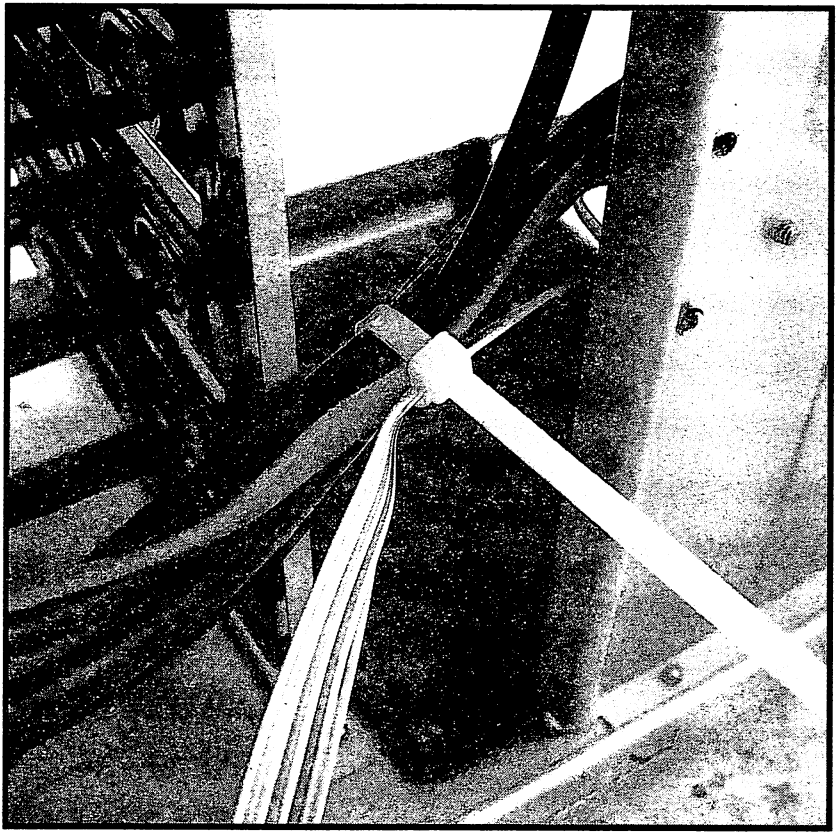


19. INSTALL FRONT PANEL CONNECTORS

The switches and LEDs on the front of all cases need to be attached to the relevant pins on your motherboard. The pinout on each motherboard is different, so you will need to refer to the instruction manual. This front panel configuration is shared by all Asus boards. Power and reset headers can be installed in any orientation on their two pins, but LEDs and speakers have a + and a – lead. In all cases, the coloured cable is positive, while the black or white cable is negative. Always double-check that you have installed the FP headers correctly or your PC will not work.

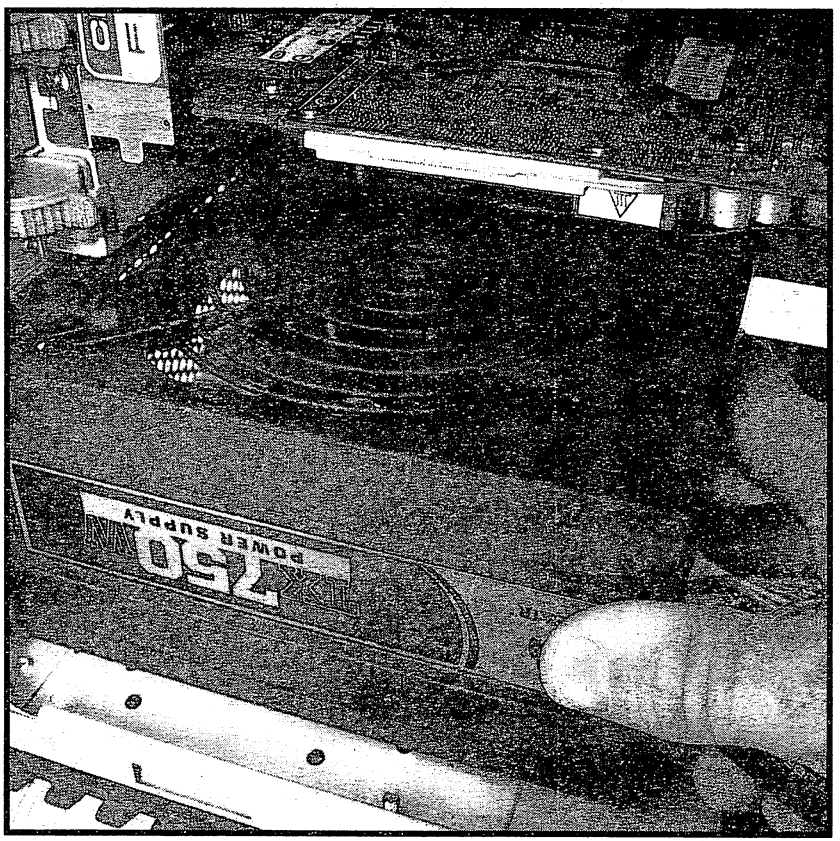
20. PLUG IN SATA CABLES

Install the SATA data cables at both the drive and motherboard ends. All SATA cables have an L-shaped connector to ensure you can only plug them in one way around. Install your primary hard disk to SATA port 1 and then populate the other ports in order. Most motherboards aren't fussy about the order you populate SATA ports in, but some throw up an error message if a hard disk is not detected on the primary port. SATA cables are far superior to IDE ribbon cables because they take up a lot less room and can be more easily routed for optimal airflow.



21. TIDY CABLES

At this point, we recommend you tidy the SATA, front panel and USB/FireWire/Audio cables you have just installed. Pull any excess slack on each cable and tether them away somewhere where they are out of the way and will not impede optimal routing of the PSU's cables. You can either use cable ties, or if you don't have any, electrical tape. In our CM-690, we pulled the excess cabling behind the hard drive bay and cable-tied them in place. This makes them invisible from view for a tidy build, and also keeps them well out of the main airflow route to significantly improve cooling.

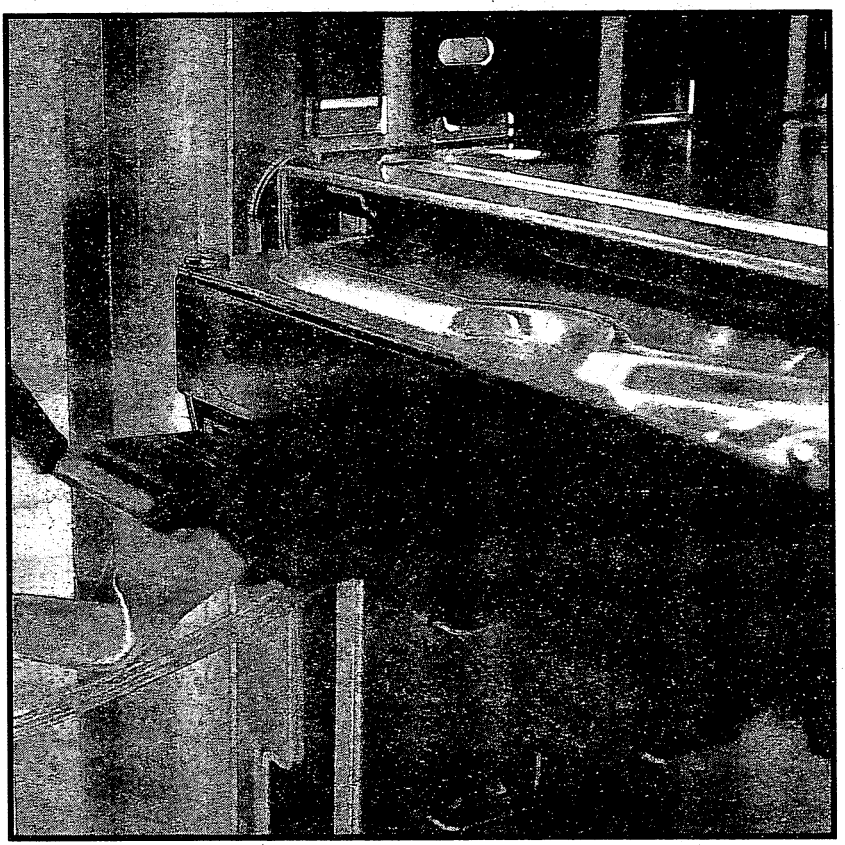


22. SCREW IN PSU

All power supplies are screwed directly to the rear of the case via four coarse-threaded screws, the same as you may have used when screwing in the hard disk. Most cases have the PSU at the rear-top of the case, where as other contemporary designs (including our CM-690) have them at the bottom. Some PSUs have front or rear-facing 80mm fans, but more and more use a single, larger fan at the bottom, as larger fans are usually quieter and move more air. If using a case with the PSU at the bottom, we recommend installing PSUs with bottom-facing fans upside down for optimal airflow.

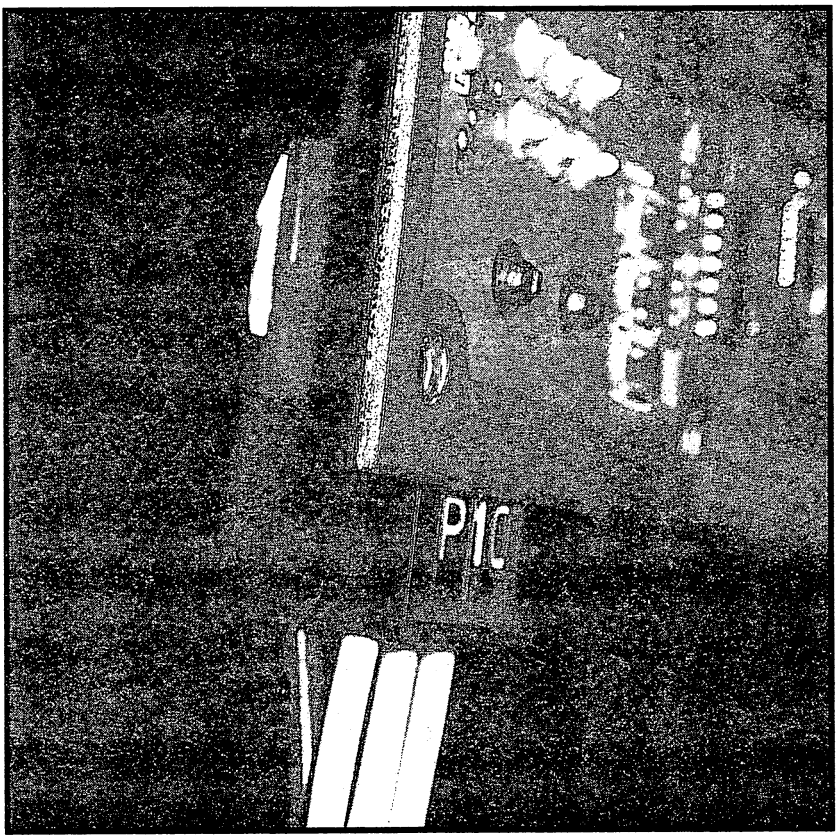
23. PLUG IN MAIN POWER LOOM

With the PSU screwed in, you can now begin to carefully route the power cables. First of all, untangle all of the separate wires and arrange them neatly in order depending on their connection type. Separate the thickest of these cables, which will be the main power loom. New boards use 24-pin power connections unless they are very low-end, while older boards use a 20-pin connector. Many PSUs allow you to detach the extra four pins for full compatibility with both types, where as others have an included adaptor lead.



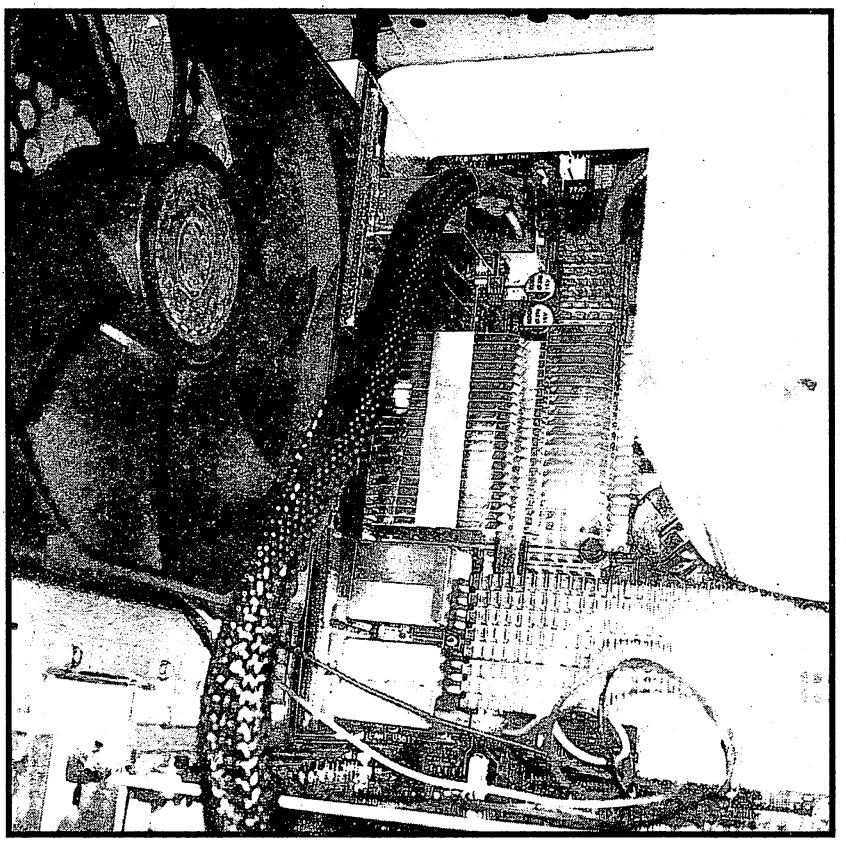
24. PLUG IN SATA POWER CONNECTORS

As with the SATA data connections, SATA power connections have an L-shaped plug that allows them to be installed in only one orientation. If your hard drive has both SATA and conventional Molex connectors, be sure to only plug in one or the other. Plugging in both could cause damage to the drive. If you run out of SATA power connections, you can purchase inexpensive adaptors that convert conventional Molex connectors for use with SATA drives. Whether you are attaching a SATA hard disk, optical disk or SSD, the rear panel is identical.



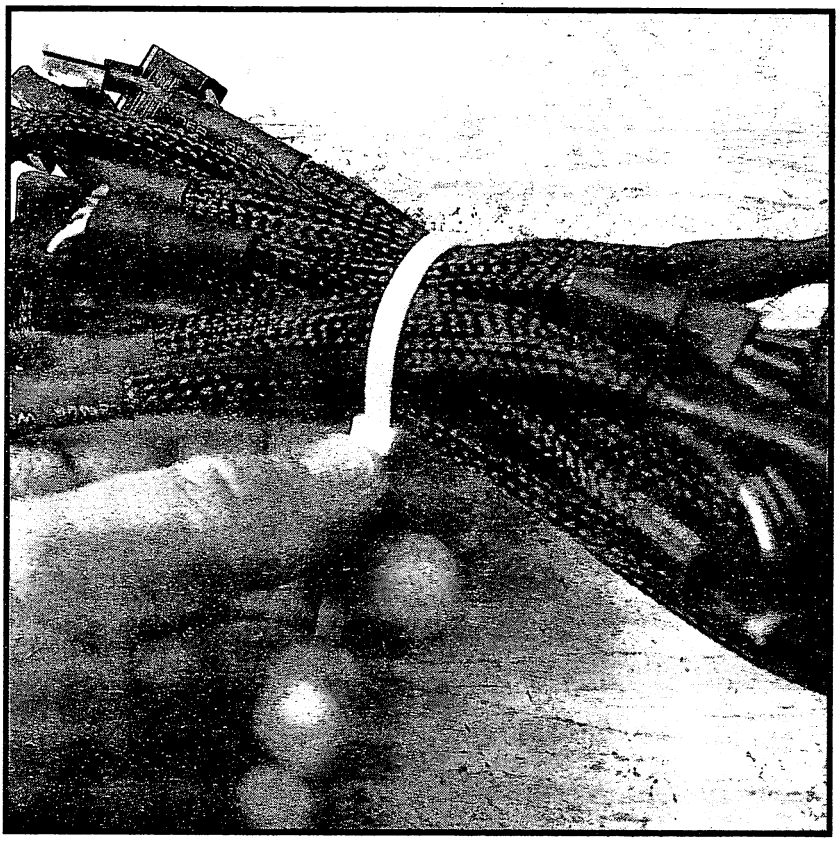
25. PLUG IN PCI EXPRESS POWER CONNECTORS

All decent video cards require additional power from the PSU, as well as the nominal supply they receive from the slot. Most mid-ranged cards have a single 6-pin connector, most high-end cards have dual 6-pin connectors, and all current flagship cards (Radeon HD 4870 X2 and GeForce GTX 280 at time of writing) use one 6-pin and one 8-pin power connection. Most video cards will not power up at all unless they receive power to the relevant connections, whereas others will display only a warning message. If you do not have enough PCI express power connectors, Molex adaptors can be purchased.



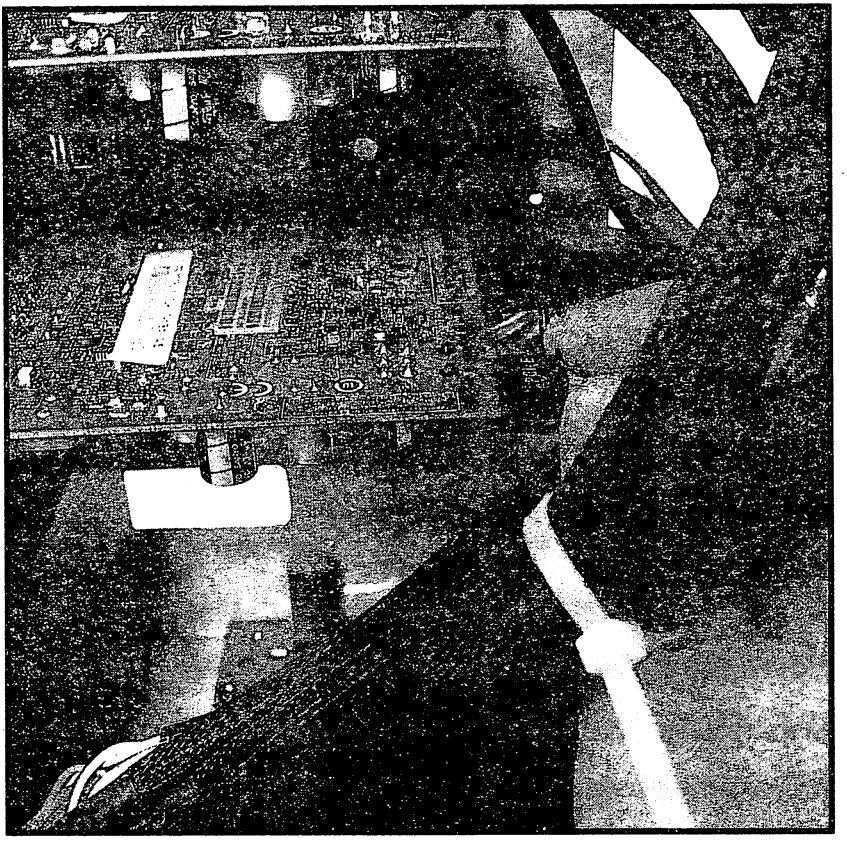
26. PLUG IN AUXILIARY POWER LOOM

All modern motherboards require an auxiliary power connector to be plugged in to supply extra current to the CPU and VRMs. In most boards, this is a single 4-pin connector, but in very high-end models you may find an 8-pin model instead. 8-pin plugs provide extra power to the VRMs and allow them to deliver a more stable output to the CPU and other components. Most decent power supplies come with either separate plugs for each motherboard type, or a single lead that can be joined or split depending on whether four or eight pins are being used.



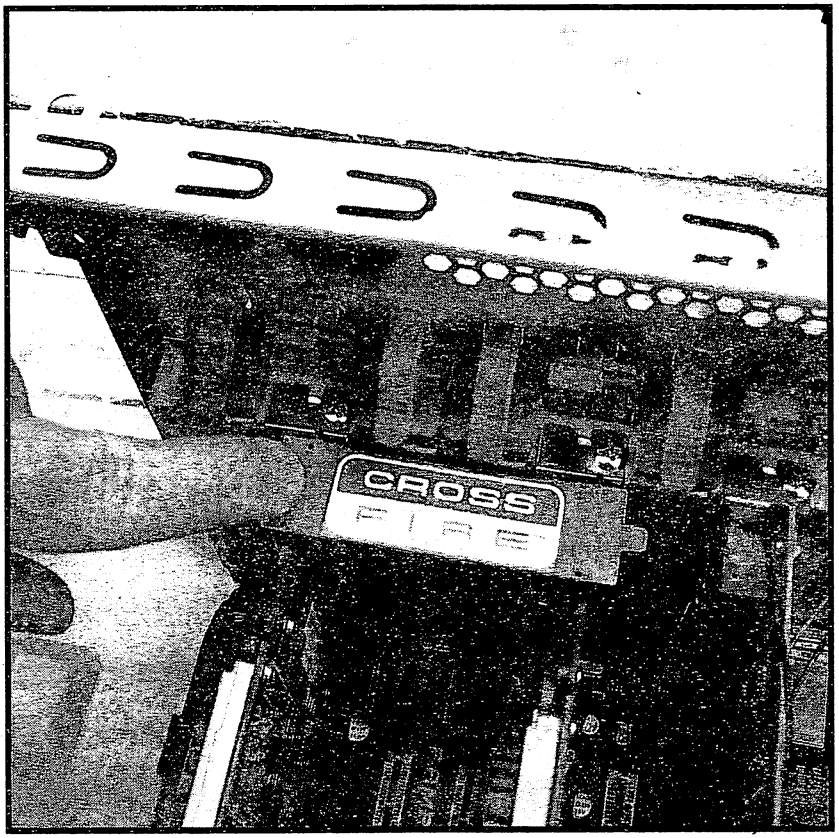
27. TIDY CABLES II

With all of the PSU cables attached, you can now tidy the cables and arrange them in such a way that they provide the minimum impedance to case airflow, and more importantly, have no chance of snagging fans should you need to move the PC case slightly. Cables that you have not used should be folded up and placed inside a spare drive bay, while excess lengths of connected cables should be gathered together and tied in place neatly. Tidy cabling is a bit of an art form, so if this is your first time, you may want to experiment with various arrangements until you find one you are pleased with.



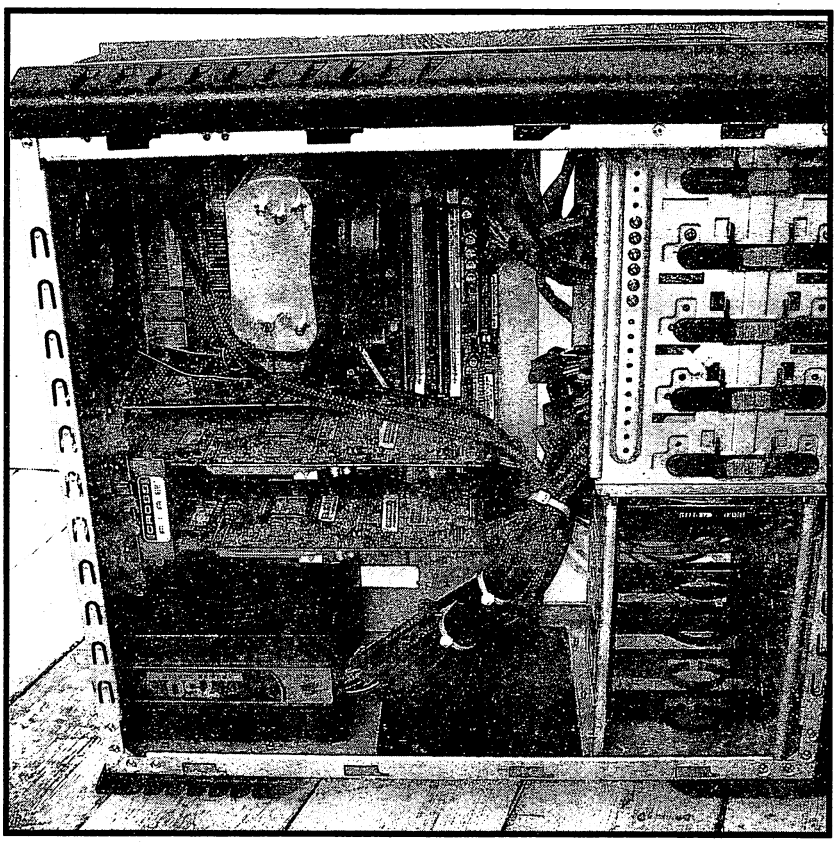
28. CABLE TIE

The trusty cable tie is one of the best ways of keeping cables tidy, but there are other, easier-to-remove tethering methods that can also be employed. Velcro straps can be purchased from any decent home/electronics shop, while electrical tape can provide a decent, though not especially secure way of keeping all the cables tied in place. Cable ties tend to be pricey from most DIY shops, but can be purchased inexpensively from builder's merchants such as Screwfix Direct. Never tether cables too tightly or the strain may cause damage to the PSU. Modular PSUs are obviously a great way of keeping things neat.



29. INSTALL SLI/CROSSFIRE BRIDGE

An easy thing to forget is to install this essential connector if you are using dual video cards. If using SLI, your bridge connector will come with your Nvidia chipset motherboard. If using CrossFire, the connector will come with the video card instead. Some cards have two sets of SLI/CrossFire bridge connectors to allow three or more cards to be attached. In this case, it is not important which connector you attach the bridge to so long as it is attached. Unhelpfully, neither Nvidia or ATI drivers let you know if the bridge connector has come off, only returning greatly reduced performance, so make sure the connector is pressed on properly!

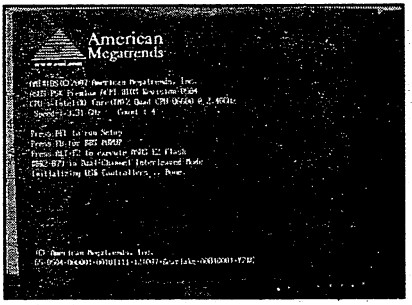


30. AND YOU'RE DONE!

Unless you have a very unusual PC configuration, you can now perform your final checks (ensure everything is mounted correctly etc), and replace the side panels. Make sure the switch on the back of the PSU is in its off (0) position, and insert the power plug. Insert only your keyboard, mouse and monitor at this stage – the rest of your peripherals can be left until later and can cause confusion during the installation of your OS, especially if they can be detected as removable storage devices like iPods or other MP3 players.

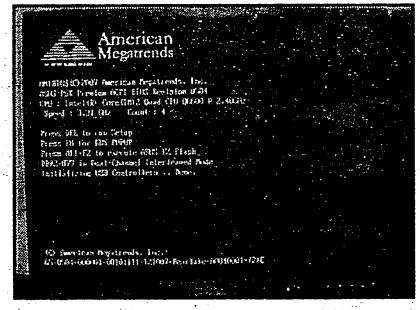
PART 5: STEP-BY-STEP CONFIGURATION GUIDE

With the PC built, all that remains is to correctly configure its settings and install the operating system.



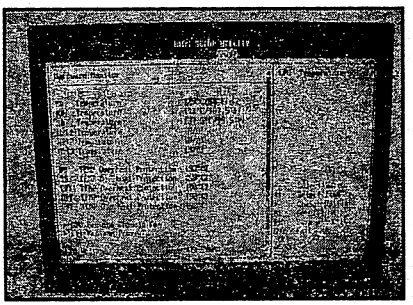
1. Fire up the PC

With the new machine built, it's time to cross those fingers and power the system on. If all has gone well, the power LED should illuminate and, if your case has a speaker, you should hear a single beep. The DOS-style screen that pops up is known as the POST sequence.



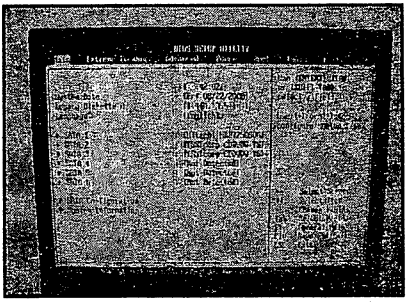
2. Press Delete/F key to enter BIOS

Which key you press to enter the setup of your motherboard depends on which model you chose, but it is normally either the Del key or one of the F keys. Refer to your documentation and press it before it tries to boot from any of your drives.



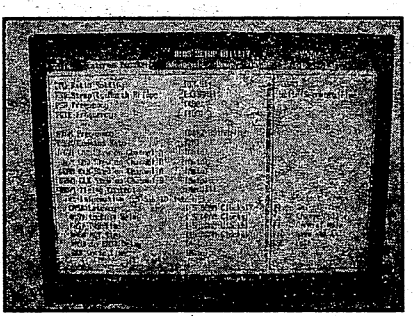
3. Check temperatures

Once in the BIOS, proceed to the Hardware Monitor or PC Health status and check your CPU temperature. Wait for ten minutes until it levels out. A modern Core 2 Quad CPU should top out at no hotter than 50 degrees when idle, while dual cores are considerably cooler still.



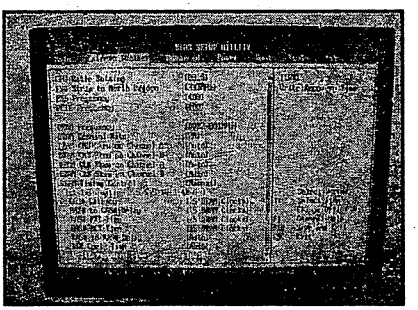
4. Set time and date

Head back to the Main page of the BIOS and set the time and date. You should do this before you install the OS, because the wrong time and date can have consequences when you come to activate or download updates. You will set the time zone later.



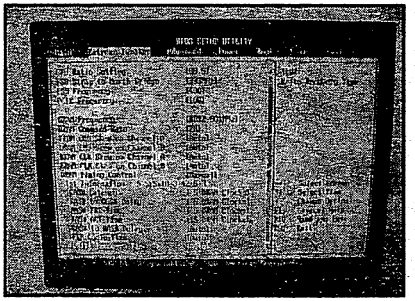
5. Set FSB frequency

All Intel chips have a default FSB frequency that will need to be set to get the correct clock speed. Most good motherboards will correctly detect this automatically, but others will require you to enter it manually. Intel chips have a default FSB of 200, 266, 333 or 400MHz.



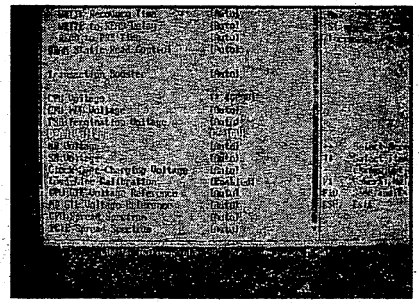
6. Set memory frequency

As well as the FSB frequency, you will also need to set the correct speed for your memory. If using PC2-6400 set it to 800 MHz, if using faster PC2-8500 memory set it instead to 1066MHz. Maximum memory speed is determined by the chipset as well as the RAM itself.



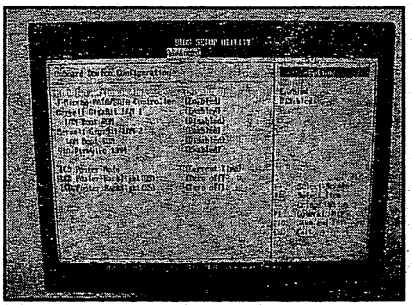
7. Set memory timings

Most memory kits have their default timings printed on a sticker attached to the heat spreader. They are listed in order of CAS, tRCD, tRP and tRAS. Common sticks have timings of 5-5-5-18, but more expensive ones can operate more tightly, for example, at 4-4-4-12.



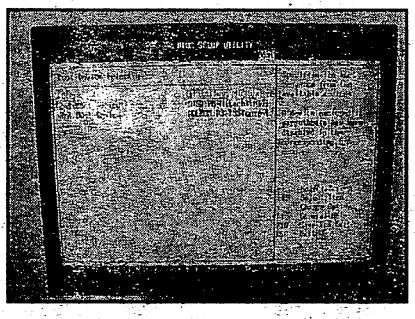
8. Set memory voltage

Most entry-level kits work quite happily at the default voltage for DDR2 memory of 1.8V, but performance modules often need more than this. You may need to unlock the board's tweaking features by setting them to 'manual' before you can adjust voltages.



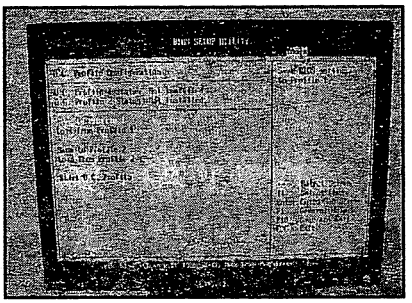
9. Disable unwanted on-board components

If you have a swanky new sound card, you won't want the motherboard's onboard sound system confusing the OS. You therefore need to disable it in the BIOS. Likewise, if you don't use FireWire or two network connections, you can disable them to free up some system resources.



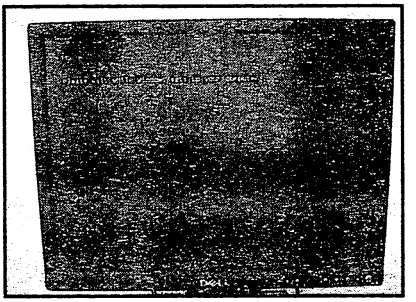
10. Set boot order

You will want to set the boot order to your primary optical drive. Most boards also let you change the boot order for each type of device, so you may have a hard drive boot priority submenu as well as the master boot order list. Once Windows is installed, setting the first device to the hard drive will speed up your boots.



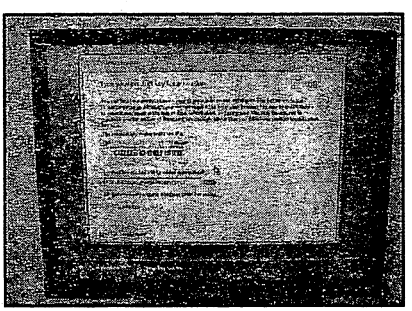
11. Save settings to profile

If your motherboard has a profile system, be sure to use it. It is a really handy tool should your BIOS forget its settings for any reason, and is also a handy baseline to refer to if you plan on overclocking or otherwise optimising the machine's performance. Our Asus allows up to two profiles.



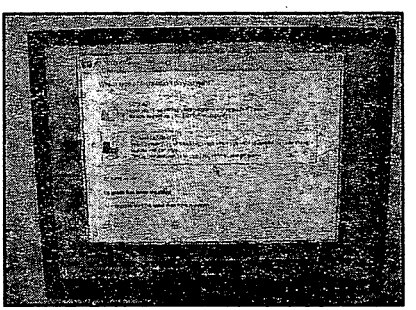
12. Insert OS disk

Press F10 to save and exit from the BIOS, or go to the exit menu and select Save And Exit. Once the system reboots, insert your Windows disk and press any key to boot from the optical drive if prompted to do so. Windows will now automatically load system files and start the install process.



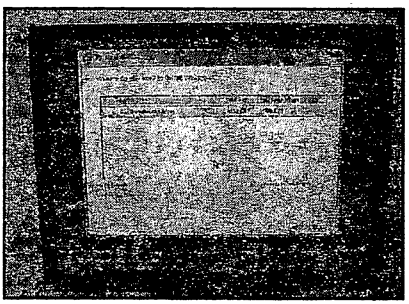
13. Enter product key

The first screen to appear that requires user interaction is the Product Key menu. Type in the key, which can be found on your Vista box, and click Next. The next stage will take some time, and your system may reboot during the process. This is normal. Do not press a key to boot from CD this time.



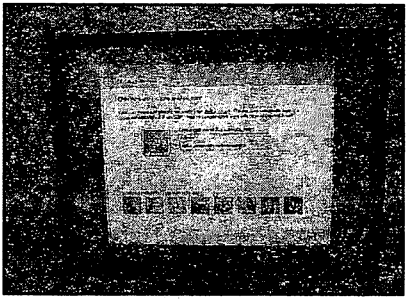
14. Select regional settings

The next screen prompts you to select the language you want, as well as the keyboard layout and other regional settings such as time and date formats. Select the UK keyboard layout and UK settings – you can always add more languages and keyboard options once within Windows.



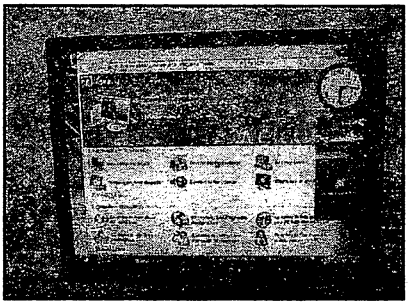
15. Select hard drive

The next step is to choose the drive you want to install Vista on. You can, if you like, also use this stage to set up partitions on the hard disk. It's a good idea to use the fastest drive in your system as the main system volume where possible.



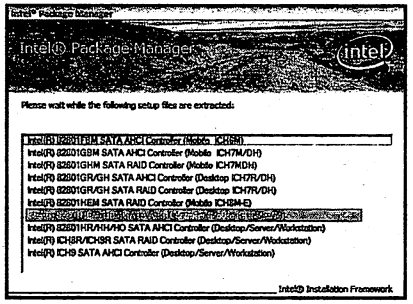
16. Enter names

Over the next few screens you will be asked to type in your name and the name you want to give your PC. You may also be asked to define the 'zone' in which your network falls. If in doubt, select 'Home' for this option. After a quick performance test, your system will finally hit the main desktop.



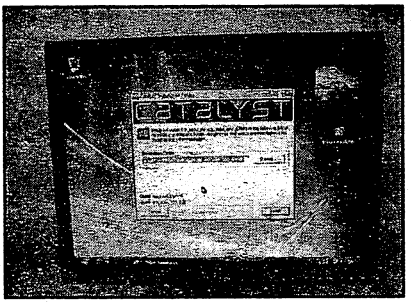
17. Turn off UAC

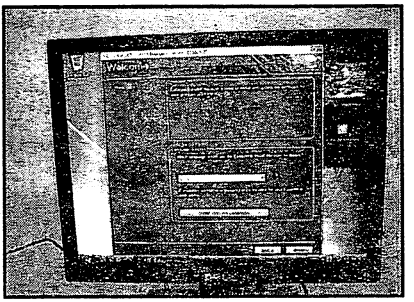
We suggest the very first thing you do is go into the Control Panel, click 'Classic Mode' on the left, click on 'Users' and disable the incredibly frustrating User Account Control – a setting that constantly asks you to confirm every action twice. UAC will greatly slow down any Vista installation.



18. Install chipset driver

After rebooting, we can now install the drivers unimpeded by UAC's annoying prompts. The first driver you should install, regardless of your motherboard, is the main chipset driver. This driver is essential as it includes all important USB 2.0 drivers as well as the correct settings for the PCI Express bus.



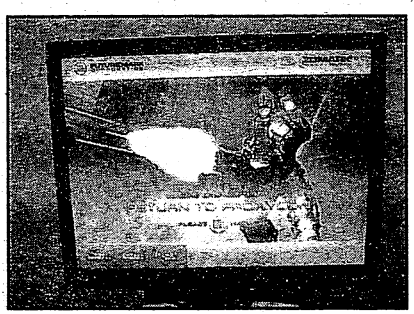


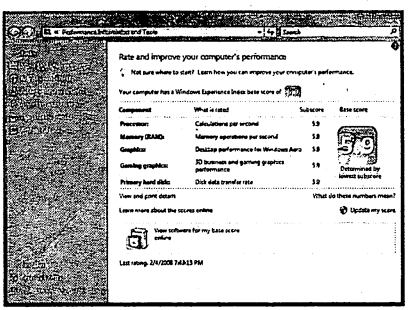
19. Install video driver

After chipset, it's time to install the video card driver, though you will probably have to restart first. We recommend you download the latest versions rather than using one that came on a disk with your card. You can get them from **www.nvidia.com** or **www.ati.com** depending on your card.

20. Install other drivers

With the two most critical drivers installed, you can now install the rest of your drivers, including those for your sound card, network card, wireless adaptors and so on. Bear in mind that many of these drivers may not be required, as Vista holds the relevant files for many of the most popular devices.



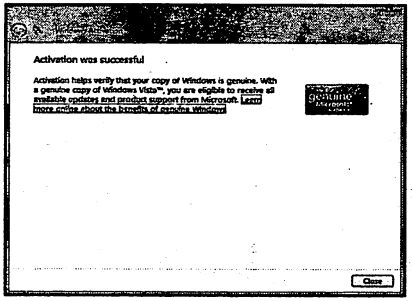


21. Test stability with Orthos/3D mark

With all of your drivers installed, we recommend you confirm the stability of your system by running intensive tasks overnight. Orthos in 'blend' mode is a great way of testing the CPU and memory, while 3DMark is a good workout for your video card.

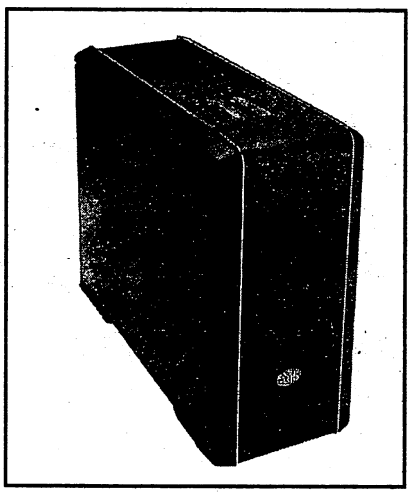
22. Run Performance Index

In the Control Panel you will find a 'Performance Index' option that will rate your hardware based on its performance. 5.9 is the maximum score any hardware can currently achieve. After determining your Index rating, Vista will adjust the visual effects accordingly.



23. Activate Windows

With all of your drivers and settings applied, you can finally log onto the internet and activate Windows. This will prevent Windows from locking your system after 30 days and enables you to download all of the updates (of which there may be dozens to download). You can also activate by phone if you prefer.



24. And you're done!

Once Windows has been activated, you can finally start to enjoy your new system, hopefully by installing all of those games you have been aching to play at maximum detail. You can now sit back, relax and let the immense sense of satisfaction that building your own PC from scratch brings!

PART 6: TROUBLE-SHOOTING

No matter how careful you are, there is always a chance of something going awry. Some components, such as CPUs and video cards, are very reliable and you would be very unfortunate to have a defective part, while other components such as memory and hard drives are more prone to problems. Rather than try to cover every scenario you might run into – which would easily fill a book twice this size – we thought it would be more helpful to point out the kind of symptoms you might see if each part is faulty. Often you will find that the symptoms overlap, in which case it's a question of swapping parts out until you find the culprit. Troubleshooting is one of the hardest things to do as a home user as, unlike a store, you won't have access to a huge array of spare hardware to throw at a problem!

Defective CPU:

If a CPU is entirely defective, a system will not POST or throw up any kind of beep error code. If it is unstable rather than totally failed (*very* unlikely), you will see crashing out of applications and blue screen errors. Use Orthos in Small FFT mode to pin down a CPU problem.

Defective memory:

One of the most common causes of problems is defective memory. Faulty memory can cause random reboots, application crashes, blue screen errors, errors with the display driver and a failure to POST if the sticks are really defective. Use Orthos in blend mode to pin down a memory problem.

Defective motherboard:

Motherboards tend to be quite binary creatures that either work perfectly or don't work at all, but occasionally you will find a board that's a bit flaky. Motherboard chipset errors cause similar symptoms to memory errors, but onboard devices disappearing may well be an early sign that all is not well with your board.

Defective video card:

A defective video card is usually manifested in games rather than under general Windows usage, though the 3D accelerated nature of Vista Aero can be revealing as well. A faulty card will sometimes cause visual anomalies or hangs when running 3D games, though it can also cause crashes back to the desktop or blue screen errors as soon as the video card driver is installed.

Defective PSU:

High quality PSUs are very unlikely to fail, but entry-level models and those that come free with cases are very prone to problems. Early signs of a PSU that is about to fail include random restarts whenever the system is under load, or unrequested shut downs if the PSU is overheating too rapidly. The same symptoms will be evident if your PSU is not powerful enough.

Defective hard disk:

A defective hard disk can be a frustrating error to track down, because it might only manifest itself when a bad sector of information is accessed. Early signs of a bad hard disk include system hangs, extremely unresponsive explorer windows, blue screen errors and an OS that never loads. You can sometimes hear failing hard drives 'tick' if you listen to them closely.

Defective optical drive

If you have problems when you try to initially boot your OS disk for the first time, there is a good chance it is caused by a faulty DVD drive. An inability to correctly read DVD or CD media once in Windows is also a fairly conclusive sign of problems with your optical drive.

Of course, not all problems are caused by defective parts. Sometimes a few setting changes in the BIOS is all that needs to be changed to get you back up and running. If your system is mostly fine but is prone to occasional instability, increase the voltage to the memory by a single increment and reduce the aggressiveness of the timings. You should also keep an eye on your temperatures within Windows using CoreTemp – a freeware application that reads temperatures straight off the CPU die.

FOOTNOTE

Modern parts tend to be well-tested before they are boxed up, so you would be unlucky to experience any problems with your PC build. If you do, you can count on help from the friendly members of our online forum, or you can always write to us for technical assistance. Whichever spec you opt for we wish you the best of luck. Happy building!

Useful programs and links:

CoreTemp
www.alcpu.com/CoreTemp

CPU-Z
www.cpuid.com/cpuz.php

GPU-Z
www.techpowerup.com/gpuz

Orthos Prime Tester
http://sp2004.fre3.com

3DMark 2006
www.futuremark.com/download

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